A Study on the Neogene Plants in the Inner Side of Central Honshu, Japan. II : On the Minoshirotori Flora (Pliocene) of the Palaeovolcano-lake Deposites.

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I : Introduction

The Minoshirotori flora was named by the writer and H. TOYA in 1963, when they made surveys in the upper reaches of the Nagara-gawa, Central Honshu, Japan, famous for the "Ukai" fishing (fishing with the cormorant).

This flora occurs in the diatomaceous mudstone layer, interbedded with the Pliocene volcanic rocks of the Southwestern Hida Plateau, Inner Side of Central Honshu, the mudstone layer being widely distributed from the Hirugano-kogen (plateau) to the Kaibutsu areas in the outskirts of the town of Gujôhachiman, Gujô-gun, Gifu Prefecture. Thus, this layer seems to have been deposited in the depression caused by the volcanic activity: this palaeovolcanic depression is named the Minoshirotori-ko (lake) after name of a Natsional Railway station of Minoshirotori of the Etsubi-Nansen Line (*Shirotori*-machi, Gujô-gun, Gifu Prefecture = Province, *Mino*).

Shirotori-machi is situated about 100 km SSE of the Kanazawa City, a distance of about 9 hours by the National Railway Bus; and 60 km NE of the Gifu City, about 3 hours by the National Railway.

By the palaeoecological and topographical considerations, the writer has become convinced that the Minoshirotori flora is a mixed deciduous temperate forest plants resembling present vegetation of the Mino mountaineous land.

The writer wishes to express his appreciation to the members of the graduates of the Kanazawa University, especially to Messrs. H. TOYA and S. NAKAMURA. This work was carried out by the grant from the scientific expenditure funds of the Ministry of Education in 1964. The writer's thanks are also due to Dr. I. HAYASAKA for his kind criticism of the work and reading the manuscripts.

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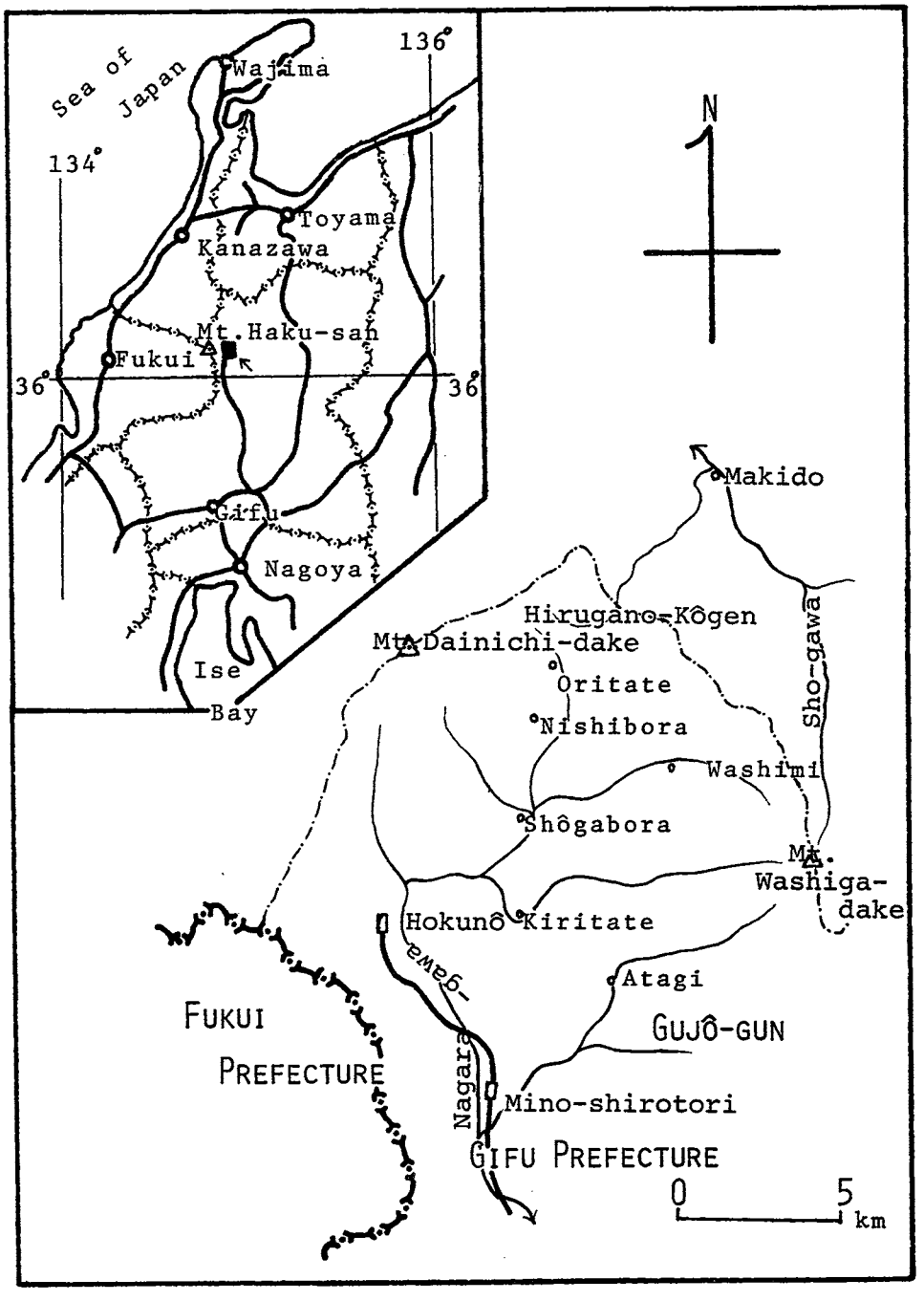
Fig. 1 : Situational map of the Minoshirotori Area.



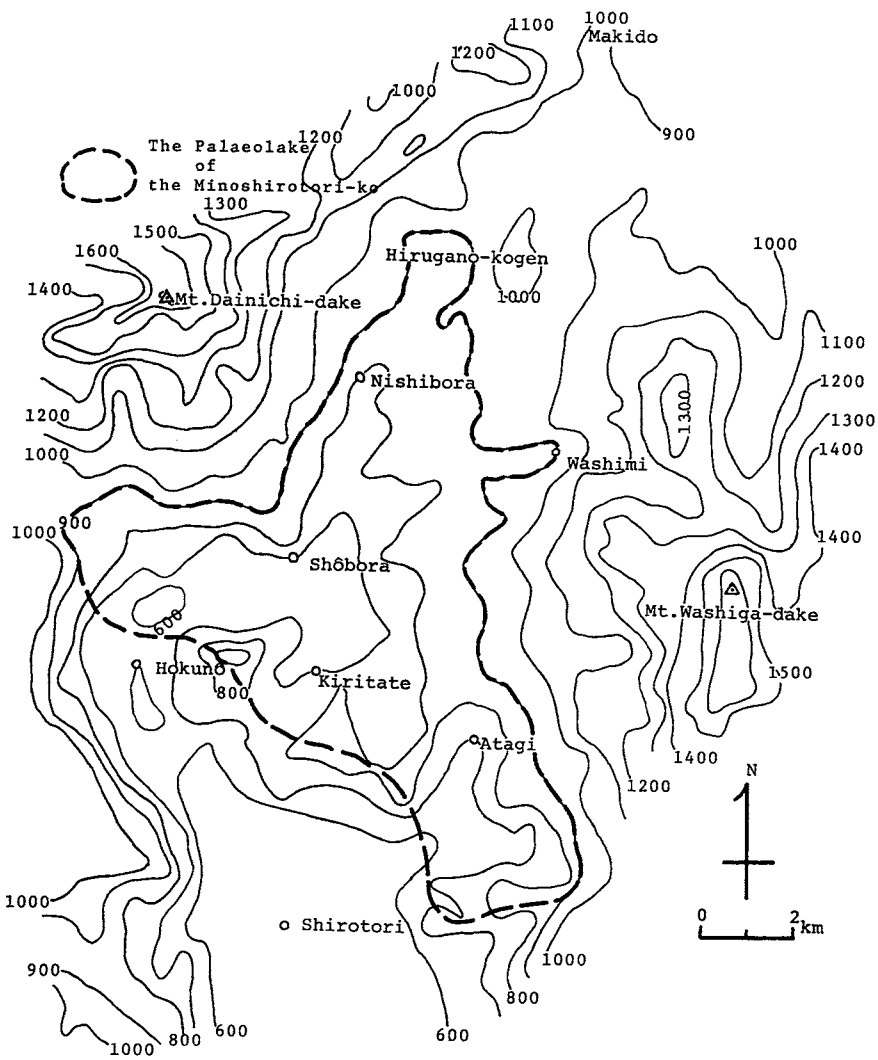
II: The Palaeovolcanic lake Minoshirotori-ko

From the topographical and geological features, the ancient form of the Minoshirotori-ko is readily assumed to have been measured across about 9 km. E-W and 15 km. N-S; and 50 km. around; mapped-area is about 100 km².

The three evidences of this palaeo-lake deposits originated something, as follows;

1) This flora occurs in the diatomaceous mud layer, which was due to the supplies of ***silica*** from the volcanic materials.

Fig. 2 : Summit map of the Minoshirotori Area (after S. NAKAMURA (MS), 1964).



2) The localities of this flora are found in one and the same horizon with the altitude of 700 m.

3) The occurrence of the Pliocene *Trapa* suggests the condition to have been a shallow basin with a muddy bottom.

The first comment: The writer considers that the volcanic ashes a vast volume of *silica* to the diatoms throughout two seasons of the year.

In the course of the present study, the writer has come across with a similar interpretation of M.N.BRAMLETTE; which is as follows (1946);

"The frequency of association of siliceous organisms and volcanic ash are noted by EHRENBERG as early as 1844; and in 1867, J. D. WHITNEY emphasized this common association in the many diatomaceous deposits of California and adjacent states, and suggested that the unusual supply of silica available in the ash might have favored the growth of diatoms. A similar view was advanced by DE LA PARENT in 1923; more recently, in 1933, TALIAFERO has reviewed the many examples of the association of diatomaceous deposits known, and he also concluded that this association was due to the large supply of silica made easily available for the development of the siliceous organisms. ..... the diatomaceous deposits of the Monterey shale contain associated pyroclastic material because they may represent comparably deep sea deposits. This hypothesis is contradicted, however, by the various lines of evidences which indicate that the Monterey deposits were not accumulated in deep seas and at an exceptionally slow rate. Volcanic ash is just as commonly associated with nonmarine diatomaceous deposits formed in shallow lakes."

His note continues "..... As REINHOLD has pointed out, the common association of diatom and volcanic ash may be due, in part at least, to the fact that delicate opaline shells would be less readily dissolved and hence more commonly preserved in beds containing volcanic ash than elsewhere, because the water within the beds contained so much silica derived from the ash that it had little solvent effect on the diatoms. But though this may be a factor in preserving some diatoms in the ash interbedded with normal sediments not largely composed of diatoms. It obviously cannot account for the larger accumulations originally consisting chiefly of diatoms. ..... One of the earliest and quantatively most important effects of the alteration of vitric pyroclastics, is a loss of silica. Great quantities of silica would thus be dissolved in sea water from volcanic ash, supplying one element highly favorable as the cause of the common association of diatoms with volcanic ash and some support for this view is found in the result oceanographic studies."

The second comment: According to the summit map of the topographical sheet "Shirotori" (1/50,000)", the present terrace-planes are assumed to be the bottom of the Minoshirotori-ko. Namely, the palaeolake was originally a volcanic depression, i.e., an an atrio-lake and/or a dammedup lake by the volcanic ejecta. Especially, the sedimentary facies of the Atagi bed is likely to be compared with deltaic deposits, having cross-bedding laminae and slump-bedding structures in the alternation of the mud and tuffaceous muddy layers.

The third comment: Numerous fruits of the Pliocene species *Trapa mammillifera* are discovered at the locality Chujô. This aquatic plant grows in ponds of which the salinity is infinitesimal; and in this condition, the plant is considered to be more thickly than otherwise.

The writer inclined, however, that the water of the *Trapa* pond is rather rich in silica due to the volcanic ash, instead of the salinity; this pond may be found to have had thicker growth than in any other conditions.

Accordingly, the Minoshirotori-ko is recognized to have been a palaeolake due to the supplies of the Late Pliocene volcanic ejecta.

III: Geological Notes of the Minoshirotori Flora

Investigations on the geology and paleophytology of the Minoshirotori-ko area have determined the horizon of the Minoshirotori flora, and ascertained its paleogeographical condition of this temperate flora.

The fundamental rock in this area consists of the Omodani rhyolitic rocks (syn. Nôhi rhyolitic rocks), which includes the Naru flora of the upper Cretaceous (H. Matsuo; 1962 and 1964).

The Atagi bed was laid in the Late Pliocene basin of the Omodani rhyolitic rocks area. This bed was divided into two members the lower and the upper, by H.Toya (1963) and S.Nakamura (1964).

The lower member consists of the characteristic muddy layer, 2~3 m. in thickness, and it yields the late Pliocene phytological evidences; namely, *Trapa mammillifera* is known as the characteristic fruit of the Japanese Pliocene water chestnut. This lower member is lithologically characterized by the andesitic tuffaceous mud and diatomaceous silty layers.

The upper member is approximately 40m. thick alternation of sandstone and conglomerate layers. These layers include the hornblende andesite boulder (maximum 100 cm. across, and cobbles 20~30 cm. are abundant), associated with the andesitic sands. According to the field observations of those layers, there seems to have been several times of the activities of the Washigatake volcano during the late Pliocene. Further, the upper member includes frequent slump-beddings in white silty tuffaceous and cross-bedding fine sandy laminae; thus, deltaic conditions took place in the palaeovolcanic basin, so that, flowed into the ancient shallow silica rich basin.

The Atagi bed was unconformably covered by the Dainichidake lava flow, which had erupted from the Hakusan Volcano in the Pleistocene age. The columnar section of the Atagi bed is shown in fig. 3.

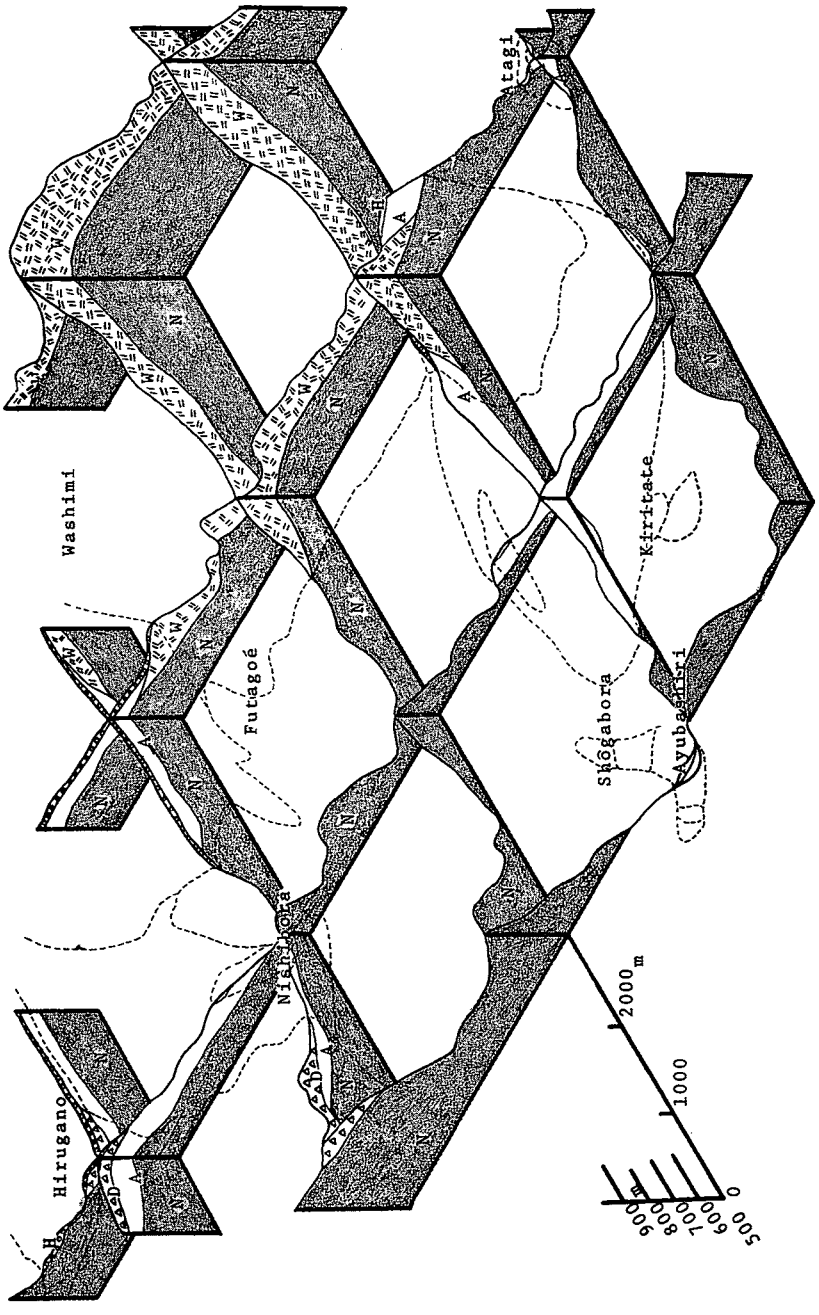
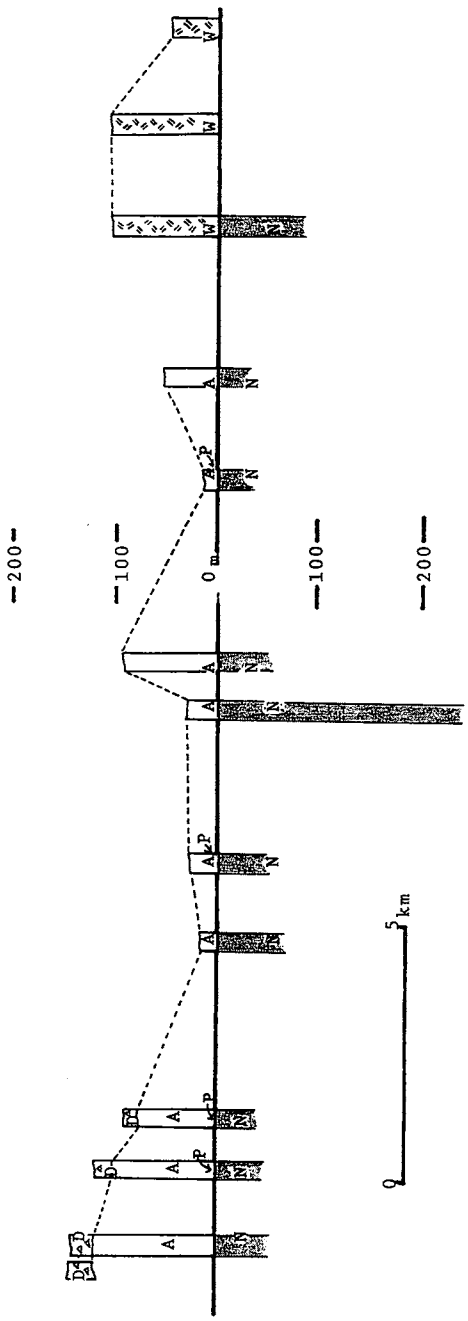


Fig. 3 : Diagrammatic columnar section of the Minoshirotori Area
(after S. NAKAMURA (MS), 1964).



H : Hirugano gravel bed
D : Dainichidake lava bed
W : Washigadake volcanics bed
A : Atagi bed
N : Nohi=Omodani rhyolitic rocks
P : Plant bearing layer

Table- 1 : Stratigraphic sequence of the Minoshirotori Area.

		H. Toya (1963 : MS)	S. Nakamura (1964 : MS)
Cenozoic	Pleistocene	Volcanic rocks (Augite hypersthene andesite) (火山岩類)	Hirugano gravel bed (蛭ケ野礫層)
			Dainichidake lava (大日岳熔岩)
	Pliocene	Atagi bed (阿多岐層)	Atagi bed (阿多岐層)
		Hado bed (羽 土 層)	Washigatake volcanic rocks (鷲ケ岳火山岩類)
Mesozoic		Naru bed (那留層)	
		Nohi (Omodani) rhyolitic rocks (濃飛 (面谷) 流紋岩類)	

IV : The modern forest in the Minoshirotori area

The Minoshirotori area occupies the valleys in the Gujô hills in the upper reaches of the Nagaragawa valley, and rangs in altitude about 400~700 m. In this area, the Nagaragawa runs from north to south, and is surrounded by the hills with mature topography in north, east, and west. In the north, there spreads the Hirugano-kogen (plateau); in the east, the Washigatake palaeovolcano, rises to the altitude of 1671.6m.; in the west, lies the Dainichidake lava dome, 1708.9 m. high which had exploded in the Pleistocene age at the western part in the Hakusan Volcano-group.

The modern forest in this area is recognized to be the habitat of the mixed deciduous temperate plants: the following list is the living species found associated with the Minoshirotori materials.

Among **Gymnosperms**

Ichii=*Taxus cuspidata* Sieb. et Zucc.

Kaya=*Torreya nucifera* Sieb. et Zucc.

Inugaya=*Cephalotaxus drupacea* Sied. et Zucc.

Harimomi=*Picea polita* Carr.

Karamatsu=*Larix leptolepis* Murray

Akamatsu=*Pinus densiflora* Sieb. et Zucc.

Goyômatsu=*P. pentaphylla* Mayy. var. *himekomatsu* Makino
Sugi=*Cryptomeria japonica* D.Don
Hinoki=*Chamaechyparis obtusa* Endlicher

Among **Dicotyledons**

Yamanarashi=*Populus sieboldi* Miq.
Yanagi=*Salix spp.*
Sawagurumi=*Pterocarya rhoifolia* Sieb. et Zucc.
Onigurumi=*Juglans mandshurica* Maxim. var. *sieboldiana* Makino
Sawashiba=*Carpinus cordata* Blume
Asada=*Ostrya japonica* Sarg.
Tsunohashibami=*Corylus sieboldiana* Blume
Udaikanba=*Betula maximowicziana* Regel
Azusa=*B. grossa* Sieb. et Zucc. var. *ulmifolia* Makino
Yamahan'noki=*Alnus hirsuta* Turcz.
Yahazuhan'noki=*A. matsumurae* Call.
Buna=*Fagus crenata* Blume
Inubuna=*F. japonica* Maxim.
Kuri=*Castanea crenata* Sieb. et. Zucc.
Konara=*Quercus serrate* Thumb.
Mizunara=*Q. crispula* Blume
Kunugi=*Q. acutissima* Carruth.
Keyaki=*Zelkova serrata* Makino
Kuwa=*Marus bombycis* Koidzumi
Kozo=*Broussonetia kazinoki* Sieb.
Hô'noki=*Magnolia obovata* Thumb.
Fusazakura=*Euptelea polyandra* Sieb. et Zucc.
Katsura=*Cercidiphyllum japonicum* Sieb. et Zucc.
Shiromoji=*Parabenzoin trilobum* Nakai.
Azisai=*Hydrangea spp.*
Marubanoki (Benimansaku)=*Disanthus cercidifolia* Maxim.
Yamazakura=*Prunus spp.*
Nemunoki=*Albizzia julibrissin* Durazz.
Fuji=*Wistaria spp.*
Kuzu=*Pueraria thunbergiana* Benth.
Yuzuriha=*Daphniphyllum macropodum* Miq.
Akamegashiwa=*Mallotus japonica* Mull. Arg.
Yamaurushi=*Rhus trichocarpa* Miq.
Nurude=*R. javanica* L.
Hauchiwakaede=*Acer japonicum* Thunberg
Urikaede=*A. crataegifolium* Sieb. et Zucc.
Itayakaede=*A. mono* Maxim.

Tochinoki=*Aesculus turbinata* BLUME
Yamabudô=*Vitis coignetiae* PUBLIAT.
Shinanoki=*Tilia japonica* SIMONKAI
Tsubaki=*Camellia japonica* L.
Urinoki=*Alangium platanifolium* HARMS. var. *macrophyllum* WANGERIN
Harigiri=*Kalopanax septemlobus* KOIDZUMI
Taranoki=*Aralia elata* SEEM.
Mizuki=*Cornus controversa* HERSL.
Aoki=*Aucuba japonica* THUNBERG
Hakuunboku=*Styrax obossisa* SIEB. et ZUCC.
Aodamo=*Fraxinus lanuginosa* KOIDZUMI
Hiiragi=*Osmanthus ilicifolius* MOUILLEFERT
Gamazumi=*Viburnum spp.*

This modern forest is characterized by two relict species, namely, Shiromoji (*Parabenzoin trilobum*) and Benimansaku (*Disanthus cercidifolia*), which are found only rarely in the *Quercus*-zone throught Central and Western Japan.

The modern climate conditions of the Minoshirotori area may be judged from the weather records at Shirotori-machi (altitude of 372 m.); average annual rainfall is 3059.6mm., half of which falls during summer; average annual temperature is 12.3°C., with the highest extreme of 34.6°C, and the lowest extreme of −13.7°C. The average temperature in July is estimated at 24.3°C., and the average minimum in January is −1.5°C. Thus, the area shows that the hot summer days are typically cloudiness, the cold winters bringing low temperature and heavy snow.

V: Composition of the Minoshirotori Flora and its Palaeoecological Condition

The Minoshirotori flora is composed of 17 families 22 genera and 30 species, including 4 families of conifers (5 genera and 5 species) and 13 families of angiosperms (17 genera, 25 species).

Comparison with the Pliocene floras of Japan: in the Minoshirotori flora, Juglandaceae and Betulaceae are meagerly represented; the Fagaceae (most abundantly *Fagus*) is well represented, but there is no record of *Castanea*. Then, this fossil flora is of warmer temperature than the other Pliocene floras, and shows a very close resemblance to the modern forest in the Nôhi mountains (especially, the down-wards of altitude of 600~700 m.).

Following list is the Minoshirotori members.

Taxaceae

Taxus cuspidata SIEBOLD et ZUCCARINI

Pinaceae

Cfr. *Picea polita* CARRIÉRE

Pinus sp. (aff. *Pinus trifolia* MIKI)

Taxodiaceae

Cfr. *Cryptomeria japonica* D.Don

Cupressaceae

Cfr. *Thujopsis dolabrata* SIEBOLD et ZUCCARINI

Betulaceae

Carpinus tschonoskii MAXIMOWICZ

C. laxiflora BLUME

C. cordata BLUME

Cfr. *Corylus heterophylla* FISCHER

Betula maximowicziana REGEL

Cfr. *Alnus hirsuta* TURCZANINOW

Fagaceae

Fagus crenata BLUME

Quercus serrata THUNBERG

Q. crispula BLUME

Moraceae

Ficus foveolata WALLICH

Magnoliaceae

Magnolia obovata THUNBERG

Trochodendraceae

Trochodendron aralioides SIEBOLD et ZUCCARINI

Aceraceae

Acer mono MAXIMOWICZ

A. rufinerve SIEBOLD et ZUCCARINI

A. sieboldianum MIQUEL

Elaeocarpaceae

Elaeocarpus japonica SIEBOLD et ZUCCARINI

Tiliaceae

Tilia japonica SIMONKAI

T. miqueliana MAXIMOWICZ

Hydrocaryaceae

Trapa natans LINNE

T. maximowiczii KORSH.

T. mammillifera MIKI

Haloragaceae

Cfr. *Myriophyllum spicatum* LINNE

Ericaceae

Tripetaleia bracteata MAXIMOWICZ

Ebenaceae

Cfr. *Diospyros kaki* THUNBERG

Zosteraceae

Potamogeton sp.

The following table—2 gives the elements of the Minoshirotori flora which have modern equivalent.

According to the table-2, the Minoshirotori flora is recognized that it should belong to the *Fagus*-zone in Japan: two reasons are recognized;

i) These characteristic elements of the *Fagus*-zone are *Carpinus cordata, Betula maximowicziana, Fagus crenata, Acer rufinerve, A. sieboldianum,* etc; among those species, *Acer rufinerve* has the relationship with the *Fagus crenata* forest, elsewhere.

ii) Among the abundant impressions of the Minoshirotori flora, *Fagus crenata* specimens have been obtained more than 150 pieces, while of the other species there are only 5 to 20 pieces.

The composition of the modern forest of the Gujô hills very closely resembles this Minoshirotori flora; there are, among these related species 13; such as *Taxus cuspidata, Picea polita, Pinus pentaphylla, Cryptomeria japonica, Carpinus cordata, Corylus heterophylla, Betula maximowicziana, Alnus hirsuta, Fagus crenata, Quercus serrata, Q. crispula, Magnolia obovata, Acer mono, Tilia japonicus.* These are cosmopolitan species in the cool to moderate temperature in Japan. But the cooler conditions of the modern forest are suggested by three species, namely, *Thujopsis dolabrata, Tilia maximowicziana* and *Tripetaleia bracteata*; these are common species of the high mountaineous Central to Northern Honshu.

Nevertheless, the following five species, namely, *Ficus foveolata, Trochodendron aralioides, Elaeocarpus japonicus, Trapa natans* and *Diospyros kaki,* suggest, on the contrary, a warmer climate than the modern Gujô hills area; these are cosmopolitan species of Western Japan.

Then, the Minoshirotori flora suggests an average annual temperature of 10° to 14°C; the highest temperature ranges between with 30° to 35°C, and the lowest is from −10° to −4°C.; and average annual rainfall is from 3,000 to 4,000 mm.

These climatic data are found in the Inner Side of from Central to Northern Honshu.

Table- 2 : Modern equivalent species of the Minoshirotori flora and their Distribution in Japan.

Fossil species	Modorn equivalent species	N. Jap.				C. Jap.					W. & S. Jap.			
		A	P	H	M	A	P	H	M	Mi	A	P	H	M
Taxus cuspidata	*Taxus cuspidata*				*				*	*				
Picea polita	*Picea polita*								*	*				*
Pinus sp. (*P. trifolia*)	*Pinus pentaphylla*				*				*	*				*
Cfr. *Cryptomeria japonica*	*Cryptomeria japonica*			*			*	*		*			*	
Cfr. *Thujopsis dolabrata*	*Thujopsis dolabrata*				*				*					
Carpinus tschonoskii	*Carpinus tschonoskii*		*	*			*	*				*	*	
C. laxiflora	*C. laxiflora*		*	*			*	*				*	*	
C. cordata	*C. cordata*			*				*		*				
Cfr. *Corylus heterophylla*	*Corylus heterophylla*			*				*					*	
Betula maximowicziana	*Betula maximowicziana*				*				*	*				
Cfr. *Alnus hirsuta*	*Alnus hirsuta*		*	*			*	*		*			*	
Fagus crenata	*Fagus crenata*		*	*				*	*	*				*
Quercus serrata	*Quercus serrata*		*	*			*	*		*		*	*	
Q. crispula	*Q. crispula*			*				*		*			*	
Ficus foveolata	*Ficus foveolata*						*					*	*	
Magnolia obovata	*Magnolia ovobata*		*	*			*	*		*			*	
Trochodendron aralioides	*Trochodendron aralioides*							*					*	
Acer mono	*Acer mono*			*				*		*			*	
A. rufinerve	*A· rufinerve*			*				*	*					*
A. sieboldianum	*A. sieboldianum*			*				*	*					*
Elaeocarpus japonicus	*Elaeocarpus japonicus*											*	*	
Tilia japonicus	*Tilia japonicus*			*				*		*			*	*
T. miqueliana	*T. miqueliana*			*										
Trapa natans	*Trapa natans*					*					*			
T. maximowiczii	*T. natans*					*					*			
T. mammillifera	*T. natans*					*					*			
Cfr. *Myriophyllum spicatum*	*Myriophyllum spicatum*	*				*					*			
Tripetaleia bracteata	*Tripetaleia bracteata*								*					
Cfr. *Diospyros kaki*	*Diospyros kaki*							*		*			*	
Potamogeton sp.	*Potamogeton distinctus*	*				*					*			

N. Jap.=Southern Hokkaido and Tohoku District; C. Jap.=Kanto, Chubu, Innerside of Kinki and Chugoku Districts; W.& S. Jap.=Outer side of Kinki and Chugoku, Shikoku and Kyushu Districts: Mi= Mino mountaineous land and Gujô hills. A=Aquatic plant; P=Plane, near stream-side and sea coast; H=Hill-side; M=Mountaineous land.

VI: Systematic Description of the Minoshirotori Flora

Taxaceae

Taxus cuspidata SIEBOLD et ZUCCARINI

Plate I, figures 2 and 3.

The material consists of well preserved foliages, having spiraly arranged leaves with linear-lanceolate and spinosus acuminate apices: mid-vein is straight. These specimens appear to be related with the Recent species *Taxus cuspidata* SIEB. et ZUCC. ("Ichi'i" in Japanese), which lives in the mountains from Central to Northern Honshu in Japan.

This is the first time that the writer has recognized the specimens of *Taxus cuspidata* in the Pliocene floras in Japan: this identification of the fossil with the Recent species, however, is guaranteed by the characteristic features of the Minoshirotori materials described above.

Locality: Kaibutsu.

Collections: Holotype=DGLAKZ-13916b (fig.3).
Hypotype=DGLAKZ-13913 (fig.2).

Pinaceae

Picea polita CARRIÉRE

Plate I, figure 4.

The fossil specimen lacks apex, but can be identified with the Recent species *Picea polita* CARR. ("Harimomi" in Japanese), which is commonly living in the mountaineous land from Central to Southern Japan. It is also very closely similar to MIKI's species *Picea bicolor* (1938; 229, III, fig. I: 1957; IV, F-H; fig. 5-A) and *P. koribai* (1948; 111, 131, II, figs. A-E: 1957; III, fig. 5-B). According to MIKI these two species are distinguished from each other, as follows (1957; 235);

„Pith of cone-axis solid with thicker constitution of cone-scale
a) Bark of cone-axis thick; conescales acute and thin at the margin, 15–40 mm. long.
1) Cone large 10–14 cm. long; conescales oblong-obovate, 4 cm. long, 2 cm. wide; bract 10 mm. long, 2 mm. wide ..... *P. koribai.*
2) Cone small, 6 cm long; conescales obovate 1.5 cm. long. ..... *P. bicolor.*"

The Minoshirotori specimen measures 7 cm. in length (apex lacking), and its obovate conescales measured 2 cm. in width. Thus, this specimen lies, in point of size, between MIKI's two species.

The living species *P. polita* has oblong-elliptical cone, 10 cm. in length; its conescales are obovate with minor serration along margin. The fossil species may be considered to be the ancient form of the Recent species.

Locality: Kaibutsu.

Collection: Holotype=DGLAKZ-13900.

Pinus sp.

Plate I, figure 5.

Though unfavorably fossilized, the specimen looks very closely resemble the Recent species *Pinus densiflora* SIEB. et Zucc., which is common in slope and upland terrain in the regions from Southern Hokkaido to Southern Kyushu in Japan.

However, H.TOYA collected one specimen of the trifoliate leaf from the Chujo locality; it may be identified with *P. trifolia* (S.MIKI; 1939) from the Pliocene lignite bed at Tajimi~Seto areas, near the Minoshirotori area, and well known for the pottery manufacture in Central Japan.

On account of the occurrence of *P. trifolia* in the Minoshirotori flora, the writer considers that the flora should be correlated with the Pliocene lignite bed flora in Central Honshu.

Locality: Atagi.

Collection: DGLAKZ-13947.

Taxodiaceae

Cfr. Cryptomeria japonica D.DON

Plate I, figures 8, 9 and 11.

The Minoshirotori foliages very closely resemble the Recent species *Cryptomeria japonica* D.DON ("Sugi" in Japanese), which is a characteristic element in the Japanese vegetation, but the writer has not been to find its cone, so that he does not decide it to be the same species as the living one.

Localities: Atagi and Kaibutsu.

Collections: DGLAKZ-13903 (fig. 8) and -13909 (fig. 9) -13927 (fig. 11).

Cupressaceae

Cfr. Thujopsis dolabrata SIEBOLD et ZUCCARINI

Plate I, figures 7 and 10.

These foliages were related to the Recent species *Thujopsis dolabrata* SIEB. et Zucc., which is a characteristic genus in Japan, commonly growings in mountaineous lands.

According to S.MIKI the Cupressacean genera are classified as follows (1958; 126);

"Shoot with 4 or 2 leaves at each joint; conescales dry; seed with wing.
a) 2 leaves at each joint ..... *Chamaecyparis*
b) 4 leaves at each joint
i) Conescale large and robust, bract of conescale thicked top ..... *Thujopsis*
ii) Conescale delicate .....*Thuja*

The *Thuja* and *Thujopsis* very closely resemble each other in shape. Because of the lack of cones among the material at hand, the identification of the fossils and the Recent forms is hardly possible.

Locality: Chujo.

Collections: DGLAKZ-13964 (fig. 10) and -13950 (fig. 7)

Betulaceae

Carpinus tschonoskii MAXIMOWICZ

Plate I, figures 12 and 13.

1888. *Carpinus* sp. NATHORST. 38, XIII, figs. 12 and 12a (leaf).
1931. *C. subyedoensis* KON'NO. VII, figs. 2-4 (leaves) and fig. 1 (involucre).
1941. *Carpinus tschonoskii*, MIKI. 266, D (involucres) and E (leaf).
1955. *C. tschonoskii*, OKUTSU. 87-89, VII, fig. 6.
1961. *C. subyedoensis*, TANAI et ONOE. 29-30, IV, figs. 3, 6 and 7 (involucres) and fig. 10 (leaf).
1964. *C. subyedoensis*, HUZIOKA. 76, VII, figs. 6, 7 (involucres), and fig. 8 (leaf).

The Minoshirotori materials (leaves and involucres) are similar to the Recent species *Carpinus tschonoskii* MAXIM. (Syn. *C. yedoensis* MAXIOMOWICZ). Now, among the living *Carpinus* in Japan, there are 4 species commonly, namely, *C. tschonoskii* ("*Inushide*" in Japanese), *C. laxiflora* BLUME ("*Akashide*"), *C. japonica* BLUME (Syn. *C. carpinoides* MAKINO; "*Kumashide*") and *C. cordata* BLUME ("*Sawashiba*"): and all these are found in hill sides and plains.

On the fossil species *C. tschonoskii*; the writer gives support to the opinion of H.OKUTSU (1955; 88), who regarded the Neogene species *C. subyedoensis* might belong to *C. tschonoskii*, because *C. yedoensis* is synonymous with *C. tschonoskii*. Besides, the Pliocene species *C. heigunensis*, which was compared with *C. yedoensis* by K.HUZIOKA (1938a: 150) should be identified with *C. tschonoskii*.

Localities: Hokuno and Atagi.

Collections: DGLAKZ-13739 (leaf) and -13788 (involucre).

Carpinus laxiflora BLUME

Plate I, figure 13; Plate II, figures 2 and 3;
Plate III, figure 7; Plate V, figure 1.

1940. *Carpinus laxiflora*, ENDÔ. 56, IV (I), fig. 4.

These small size leaves and involucres are identified with the living *Carpinus laxiflora* Blume (*"Akashide"* means a red hornbean), which is a species commonly growing in hill sides and plains in Japan.

The Minoshirotori materials are identical with the Shiobara species, reported by S.ENDÔ in 1940.

Locality: Hokuno.

Collections: DGLAKZ-13787, -13829, -13863 and - 13796 (leaves);
DGLAKZ-13737 (involucre).

Carpinus cordata BLUME

Plate II, figure 7.

1940. *Carpinus cordata*, ENDÔ. 54, VII (V), figs. 5 and 10 (involucres), figs. 9, 13 and 19 (leaves).

This incomplete hornbean-like leaf is similar to the living species *Carpinus cordata* BLUME (*"Sawashiba"* means a marsh hornbean), which is found in the forests of Central and Northern Honshu, flourishing along the stream sides in mountaineous region.

The Minoshirotori materials are impressions quite identical with those of the Shiobara fossils (ENDÔ; 1940).

Locality: Hokuno.

Collection: DGLAKZ-13894 (fig. 7)

Cfr. Corylus heterophylla FISCH.

Plate I, figure 15.

This incomplete impression is similar to the living species *Corylus heterophylla* FISCH. (*"Hashibami"* in Japanese, means a hasel), which is found in the sunny hill sides in Japan.

The writer regards that this material belongs to the genus *Corylus*, beacuse 1) although this specimen lacks apex and base, it has the double serration, which is regarded as one of the characters of the Betulaceae; 2) the form of the double serration is more similar to than to other Betulaceaen leaves; and 3) the form of the arch-shaped third veins are more like those of the living species than the those of *C. sieboldiana* BLUME.

The Minoshirotori material very closely resembles the Aburado species *C. subsieboldiana* Suzuki (lower Miocene age), which was reported by K.Huzioka (1964; 77, VII, fig. 9). The original note with figures of *C. subsieboldiana* were prepared by K.Suzuki (1961; 45-46, X, figs. 3 and 4) on the material from the Ryozen formation (lower Miocene), it strongly resembles the living *C. sieboldiana*. However, Huzioka's figure is similar to the Minoshirotori material, so that the writer considers that the former species is identified with the living *C. heterophylla*.

Locality: Hokuno.

Collection: DGLAKZ-13943.

Betula maximowicziana REGEL

Plate II, figure 8.

1940. *Betula maximowicziana*, Endô. 52, V (II), figs. 9 and 11 (seeds), 10, 19 (leaves), 15 (braclet); X (VII), fig. 13 (braclet), 20 (seed); XI (VIII), fig. 11 (seed).

1955. *B. maximowicziana*, Okutsu. 89-90, IV, figs. 3 and 4.

This double serrated incomplete leaf-impression is similar to the Recent species *Betula maximowicziana* Regel (*"Udai-kanba"* in Japanese), which is found in the mountaineous land in Central and Northern Honshu, Japan.

The characteristic features of the Minoshirotori material are very closely similar to those of the Shiobara species *B. maximowicziana* by S.Endô in 1940 from the Pleistocene deposits, and the Shirasawa species (upper Miocene) *B. maximowicziana* by H.Okutsu in 1955, very closely resembles this material.

This Minoshirotori species is regarded to be *B. maximowicziana* in Pliocene age in Japan.

Locality: Atagi.

Collection: DGLAKZ-13803.

Cfr. Alnus hirsuta TURCZANINOW

Plate II, figure 1.

The incomplete specimen at hand is similar to the living species *Alnus hirsuta* Turcz. (*"Yama-hannoki"* in Japanese, meaning a Mountain alder), which is commonly found in the mountaineous lands and hill sides in Japan. And this specimen is identical with the Shiobara species *A. hirsuta* var. *sibirica* C.K. Schneider, as reported by S.Endô (1940: 50-51, X, figs. 3 and 22).

Locality: Hokuno.

Collection: DGLAKZ-13786.

Fagaceae

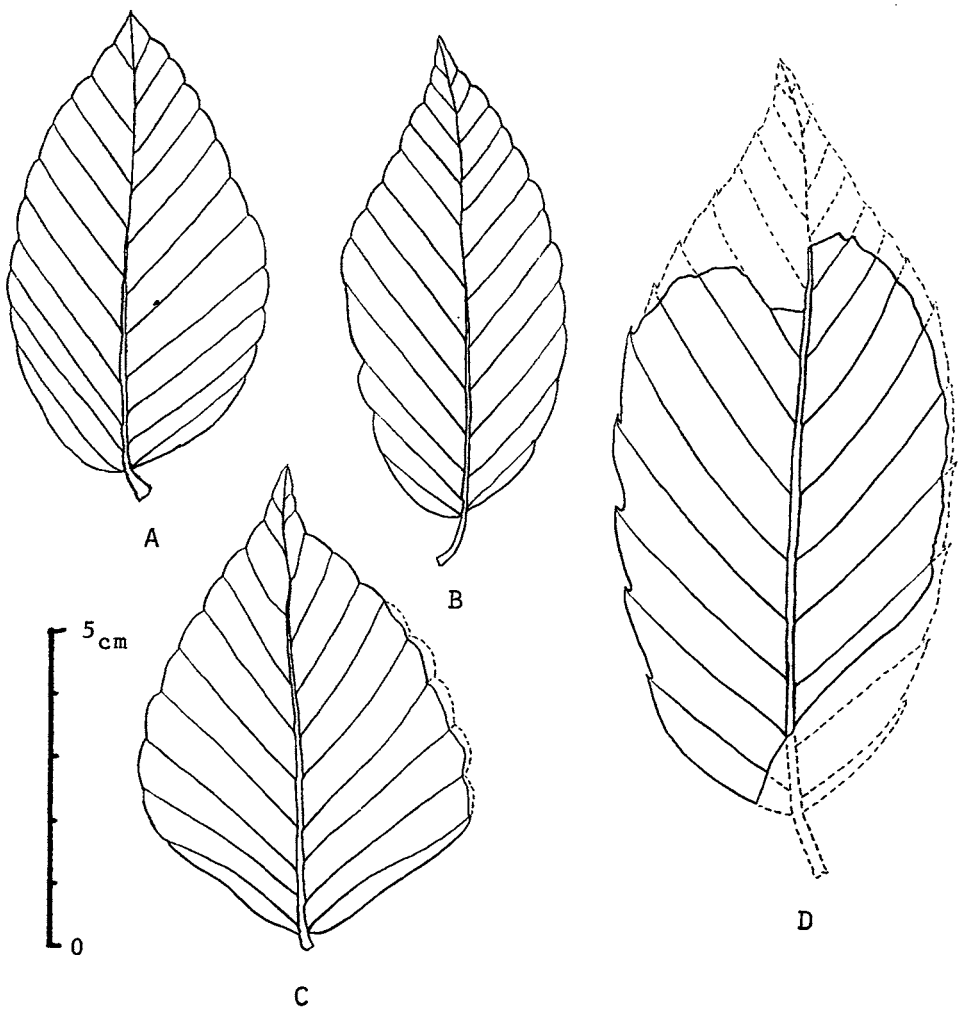
Fagus crenata BLUME

Plate III, figures. 1-4, 8 and 9, Plate IV, figures 1 and 8; Plate VI, figure 6.

When K.HUZIOKA established three new species of the Korean Miocene beeches in 1951, he compared those new Miocene species with the living ones in the Northern Hemisphere, namely, *Fagus hayatae* PALIB. in Formosa (Taiwan), *F. longipetiolate* SEEMEN in China, *F. ferruginea* AIT., and *F. lucida* LEHDER et WILSON in N. America, and *F. crenata* BLUME in Japan.

Among those Recent species, *F. crenata* has two kinds of shape of the leaf margin, the one is a crenate margin as the specific name shows, and the lateral veins reach to the crenated dents; the other is finely serrate and craspedromus.

Fig. 4 : *Fagus crenata* from the Atagi bed.



These features were pointed out by H.OKUTSU in 1955, when he established the new Miocene species *F. palaeocrenata* from Sendai area, N. Honshu. He recognized that the crenate species is *F. palaeocrenata* (1955; 92-93).

The living beech, *F. ferruginea*, shows a typically serrate margin, and so the foreign palaeophytologists consider that it flourished in the Miocene age in Japan.

In the modern forests in Japan, are commonly found *F. crenata* BLUME ("*Buna*" in Japanese) and *F. japonica* MAXIMOWICZ ("*Inubuna*") in the mountaineous lands Honshu. The former species is synonymous with *F. ferruginea* AIT. and *F. sylvatica* L., and flourished in the subalpine belt in Central Honshu (altitude of 900 m.; but in Northern Honshu, it is found in the plains). The latter, *F. japonica* is synonymous with *F. sieboldi* ENDLICHER, and is found in the forests in the mountaineous lands in Japan.

Among the Mio-Pliocene beech leaves from the Ningyo-toge area, T. TANAI minutely described a living species intermediate between two fossil species (*F. palaeocrenata* and *F. palaeojaponica*), which are recognized the ancestral species of the Recent species *F. crenata* and *F. japonica*, respectively.

The writer tries a correlation of living and fossil species in the following table-3.

Table-3: A Correlation of Living and Fossil Species of *Fagus* in Japan.

Species / Morphological Characters	Living species (MAKINO: 1963)		Fossil species	
	Fagus crenata BLUME	*Fagus japonica* MAXIMOWICZ	*Fagus paleocrenata* OKUTSU	*Fagus palaeojaponica* TANAI & ONOE
Shape	Ovate or rhomboid elliptical	Ovate or elliptical ovate	Ovate-broad elliptical	Elliptical or long-ovate
Apex	Acute	Acuminate	Acminate	Acute-Acuminate
Asymmetry Base	Cuneate	Attenuate or obtuse	Rounded or broadly cuneate or cuneate	Obtuse or rounded
Lateral veins	7–11 pairs	10–14 pairs	8–13 pairs	13–16 pairs

As shown in the table-3, *F. japonica*-type has few a slightly more lateral veins than the *F. crenata*-type.

The Minoshirotori fossil leaves show the characteristic features (i. e. in shape and lateral veins) of the living species *F. crenata*, but the apex and the base are similar to *F. palaeojaponica*.

Nevertheless, the writer is inclined to recognize that these are to be identified with the *F. crenata*: he tries to sketch three forms of this species.

Localities: Atagi, Kaibutsu, Hokuno and Chujo.

Collections: DGLAKZ-13786, -13740, -13752, -13741, -13789, -13791, -13770, -13734 and -13821.

Quercus serrata THUNBERG

Plate III, figure 6a; Plate IV, fig. 2.

These oblong-ovate or elliptical leaves are very closely similar to the *Quercus* sp. which was described by T.TANAI and T.ONOE from the Ningyo-tôge area (1961 : 32-33, V, fig. 5). According to their notes, the incomplete Ningyo-tôge specimen are comparable with the living species *Quercus serrata* THUNBERG, or *Q. acutissima* CARRUTH., which are found in the hill side areas in the Far East.

The Minoshirotori materials are more similar to the Recent species *Q. serrata* (*"Konara"* in Japanese), which is found very commonly in the hill sides, in contrast to *Q. acutissima* (*„Kunugi"*).

Description: Leaves small in size, 5~10 cm. long, and 3~5 cm. wide, oblongovate or elliptical in shape, apex acuminate, base cuneate or rounded-cuneate; midrib stout, lateral veins 15~18 subalternate pairs and craspedromus; margin dentate asymmetrically acute teeth.

Localities: Hokuno, Atagi and Chujo.

Collections: DGLAKZ -13952, and -13956b.

Quercus crispula BLUME

Plate IV, figures. 3, 4 and 6; Plate V, figure 3.

1930. *Quercus dentata*, KON'NO (in part). III, fig. 4 (not fig. 5).
1940. *Q. crispula*, ENDÔ. 60, VI (III), fig. 1; X (VII), fig. 7.
1954. *Q. miocrispula* HUZIOKA. 196, XXV, fig. 3.
1961. *Q. miocrispula*, TANAI et ONOÉ. 30-31, VI, figs. 1, 2 and 6.

On the Miocene species *Quercus miocrispula*, K.HUZIOKA established a new species from Southern Korea (1954), which is evidently similar to the Recent species *Q. crispula*.

About the Mio-Pliocene species *Q. miocrispula*, TANAI and ONOÉ (1961) considered that the Ningyo-tôgé species is almost identical with the living species.

Now, the well preserved Minoshirotori impressions of the medium sized oak leaves show the typical characters of the above mentioned *Q. miocrispula*. Then, these specimens should be compared with the Recent species *Q. crispula* (*"Mizu-nara"* in Japanese), which is widely distriduted in the mountaineous lands of Japan.

Localities: Atagi, Kaibutsu and Hokuno.

Collections: DGLAKZ-13804, 13784, -13833 and -13753.

Moraceae

Ficus foveolata WALL.

Plate IV, figure 7.

A small, entirely lanceolate-oblong leaf is very much like the living species *Ficus foveolata* WALL. (*"Itabi-kazura"* in Japanese), which is found in South-western and Central Japan.

This Minoshirotori material is similar to the Miocene species *Qercus elliptica* from the Yoshioka flora in Hokkaido, which was established by T.TANAI and N.SUZUKI in 1963 (121-122, XII, fig. 1; XIV, figs. 1 and 2). But the lowest secondary vein of the Minoshirotori specimen is derived from the petiole, while the Yoshioka specimen shows the parallel veins.

Description: Leaf lanceolate oblong, entire in margin, apex acute, base rotundate, 53 mm. in length, and 24 mm. in width; midvein stout, basal lateral vein divered from the petiole, and 8 pairs of parallel secondary veins looping in marginal part; short petiole; coriaceous texture.

Locality: Hokuno.

Collection: Holotype=DGLAKZ-13736.

Magnoliaceae

Magnolia obovata THUNBERG

Plate VIII, figure 3.

1940. *Magnolia obovata* ENDÔ. 63, XII(IX), fig. 3.

This large incomplete leaf is very closely similar to the Shiobara specimen, which was described by S. ENDÔ in 1940 from the living species *M. obovata* THUNBERG (*"Ho'onoki"* or *"Hô-gashiwa"* in Japanese), which is found in the mountaineous and hill side forests in Japan.

Locality: Atagi.

Collection: DGLAKZ-13867.

Trochodendraceae

Trochodendron aralioides SIEBOLD et ZUCCARINI

Plate VI, figure 7.

Description: Leaf oblong-lanceolate, asymmetrical base cuneate, apex lost; 55 mm. long, and 20 mm. wide, serrulated margin on upper half; texture coriaceous. Petiole stout, 16 mm. long. Primary nerve straight and stout, secondary nerves diverging from the primary at angles of about 50 degree.

This leaf impression is similar to the living evergreen species *Trochodendron aralioides* SIED. et ZUCC. ("*Yamaguruma*" or "*Tori-mochi-noki*=Birdlime wood" in Japanese), which is found in the mountaineous land in Southwestern and Central Japan.

The Pleistocene species *Trochodendron aralioides* var. *longifolium* MAXIM. of the Shiobara flora was named by S. ENDÔ in 1940(61, XI (VI), fig. 4), but the writer regards that the Shiobara specimen is similar to the Magnoliacean species *Kadsura japonica* DUNAL, instead of the Trochodendraceae.

Locality: Hokuno.

Collection: Holotype=DGLAKZ-13797.

Aceraceae

Acer mono MAXIMOWICZ (Syn. *Acer pictum* THUNBERG)

Plate VI, figures 1, 4 and 5.

1888. *A.* cfr. *pictum*, NATHORST. 232, XIII(XXX), figs. 1 and 2.
1934. *A.* *pictum*, ENDÔ. 247-248, XXIX, figs. 3, 4 7-9; XXX, fig. 2; XXXI, figs. 4 and 5; XXXII, figs. 3 and 6.
1940. *A.* *subpictum* SAPORTA, HU et CHANEY. 61-62 XXXIV, figs. 3 and 5 (sammaras), 4 and 7 (leaves); XXXV, fig. 1.
1943. *A.* *subpictum*, ÔISHI et HUZIOKA. 93-94, XIII(V), figs. 1-4; XIV(VI), figs. 3 and 4.
1943. *A.* *subpictum*, HUZIOKA. 129-130, XXIV(IV), figs. 4-6; XXV(V), fig. 3.
1952. *A.* *subpictum*, TANAI. 131, IV, fig. 7.
1954. *A.* *subpictum*, TAKAHASHI. 60, VII, figs. 3, 4a and 4b.
1955. *A.* *picum*, OKUTSU. 103, VII, figs. 1, 2 and 8.
1959. *A.* *matsuii* TANAI et ONOÉ. 282, VI, figs. 1 and 13 (samara).
1960. *A.* *subpictum*, TANAI et N. SUZUKI. 576-568, IV, figs 1-4; VII, figs. 3-6.
1961. *A.* *subpictum*, TANAI et ONOÉ. 51, XVI, figs. 4-6.
1961. *A.* *subpictum*, TANAI. 365-366, XXVII, fig. 1; XXVIII, fig. 22.
1963. *A.* *subpictum*, TANAI. et N. SUZUKI 142, XXI, figs. 7 and 9 (samara).
1963. *A.* *subpictum*, HUZIOKA. 209, XXXIII, fig. 1.
1964. *A.* *subpictum*, HUZIOKA. 93, XV, figs. 11 and 12 (leaves), 13 13 (samara).

These Minoshirotori leaf impressions have also resemble the living species *Acer mono* MAXIMOWICZ ("*Itaya-kaéde*", "*Tokiwa-kaéde*" and *Tsuta-momiji*= Ivy-red leaves or Ivy-autumnal tints"); which is found in the mountaineous lands in Japan.

The non-serrate, 5~7 lobed palmate leaf impression of the Miocene *Acer* occur in China, Korea, Sakhalin and Japan, and called *Acer subpictum* SAPORTA by many palaeophytologists, and they have compared it with the living *A. mono*.

Localities: Hokuno, Atagi and Chujo.

Collectious: DGLAKZ-13876, -13769 and -13957.

Acer rufinerve SIEBOLD et ZUCCARINI

Plate VIII, figure 2.

1951. *Acer rufinerve*, ENDÔ. 53, VIII, fig. 4 (leaf) and fig. 5 (samara).

This incomplete double serrate leaf impression is very closely similar to the living species *Acer rufinerve* SIEB. and ZUCC. (*"Urihada-kaéde"* in Japanese), which is found in the *Fagus*-zone of the Honshu, Shikoku, and Kyushu, in Japan.

The upper Miocene species *A. rufinerve* was described by S. ENDÔ (1951) from the Shirasawa formation, at Nishizawa (leaf) and Nashino (samara), Natori-gun, Miyagi Prefecture. The Minoshirotori specimen at hand resembles the Recent species rather than the Nishizawa specimen, as regards the characteristic features of the double serrate margin.

The upper Miocene species *A. palaeorufinerve*, which was established by TANAI and ONOÉ in 1960 (1961 : 49-50, XVI, fig. 2 (leaf) and fig. 3 (samara)) from the Mitoku formation; and the Miocene species *A. paleorufinerve* was reported by T. TANAI and N. SUZUKI in 1960 (563-564, V, fig. 4) from the Yoshioka and Kaminokuni floras. These leaf materials are similar to the Minoshirotori specimens, but these Miocene materials are not found with the double serrate lateral lobes, so that, the Minoshirotori species is considered to differ from the Miocene species *A. palaeorufinerve.*

Locality : Atagi

Collection : DGLAKZ-13802.

Acer sieboldianum MIQUEL

Plate VI, figure 3.

This incomplete leaf is very resembles the living species *Acer sieboldianum* MIQ. (*"Yama-momiji"* in Japanese, means a mountain maple), which is found in the mountaineous lands in Central and Northern Honshu. On the other hand, *A. palmatum* THUNBERG (*"Momiji"*, *Takao-momiji"* and/or *"Iroha-kaéde"* in Japanese) is commonly found in the mountaineous lands in Shikoku and Honshu.

The lobed piece of the Minoshirotori material is somewhat shallower and broader than the *A. palmatum*, and the Shiobara species *A. euseptenlobum* KOIDZUMI (S. ENDÔ; 1934; 241, XXXII, figs. 7 and 8 (leaves); XXXV, fig. 11 (samara)). Thus, the writer regards that this half incomplete leaf impression certainly belongs to *A. sieboldianum.*

Locality : Hokuno.

Collection : DGLAKZ-13789.

Elaeocarpaceae

Elaeocarpus japonicus SIEBOLD et ZUCCARINI

Plate V, figures 7 and 8; Plate VI, figures 8 and 9.

This is a coriaceous and fine flatly serrate leaf impression, similar to the living species *Elaeocarpus japonica* SIEB. et ZUCC. (*"Kobanmochi"* in Japanese; syn. *E. kobanmochi* KOIDZUMI), which is found in Japan, Ryukyu, Taiwan and Central China.

Description: Leaf elliptical ovobate, fine flatly serrate in margin, apex cuspidate obtuse, base obtuse; more than 75 mm. in length and 37 mm. in widest part (at the 1/3 upper part); midvein stout, coriaceous texture.

Discussion: This material closely resemble the living species *Stawartia pseudo-camellia* MAXIMOWICZ (*"Natsu-tsubaki"* or *"Sharanoki"* in Japanese), which is commonly found in mountaineous lands in Japan. However, the shape and flat-serration of the former species is similar to *Elaeocarpus japonica* rather than the latter and the other Theacean leaves.

Locality: Hokuno.

Collections: Holotype=DGLAKZ-13734; Hypotypes=DGLAKZ-13794, -13764 and -13780a.

Tiliaceae

Tilia japonica SIMONKAI

Plate V, figures 4 and 5; Plate VII, figures 3 and 6.

1888. *Tilia* sp., NATHORST. 225, VII (XXIII), fig. 13.
1931. *T. distans*, KON'NO. XIV, fig. 4.
1940. *T. japonica*, ENDÔ. 68-69, IV (I), fig. 1; VIII (V), fig. 7 (leaves) and 19 (bracteole).
1943. *Tilia distans*, HUZIOKA. 121-123, XXI (I), figs. 1-4, 7 and 8 (bracteoles of *Tilia* sp. by HUZIOKA).
1943. *T. japonica*, HUZIOKA. 123-124; XXJ (I), fig. 6.
1952. *T. distans*, TANAI. 132, IV, fig. 9.
1954. *Tilia* cfr. *japonica*, TAKAHASHI. 62, VII, fig. 9.
1961. *Tilia distans*, TANAI 367, XXVIII, figs. 3 and 4; XXIX, fig. 2; XXX, fig. 6 (bracteole).
1961. *T. protojaponica*, TANAI. 369, XXX, fig. 7.
1961. *T. ryosenensis* SUZUKI. 84, XIX, fig. 1.
1961. *T. kon'noi* SUZUKI. 85-86, XIX, figs. 2 and 3.
1962. *T. protojaponica*, TANAI. 143-144, XVI, figs. 1, 3 and 7 (leaves), figs. 2 and 5 (bracteoles).

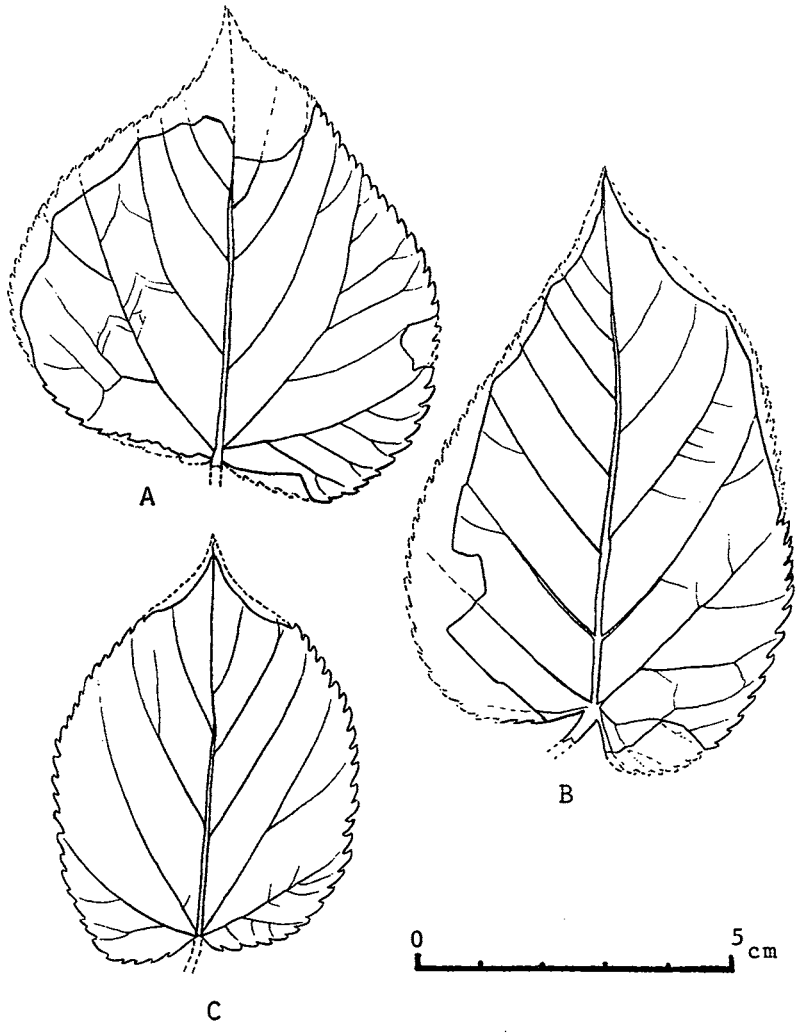
These small and medium leaves are very closely resemble the living *Tilia japonica* SIMONKAI (*"Shinanoki"* in Japanese), which now flourishes in Japan, and is found at the mountaineous lands (altitude of 600 to 1,000 m.) in Central Honshu.

The hitherto known species, namely, *T. distans*, *T. protojaponica*, *T. ryosenensis*, and *T. kon'noi* are known in Japan from the Miocene, Pliocene, and Pleistocene formations. These four species were considered to belonging to the living species *T. japonica*.

Locality: Hokuno, Atagi and Chujo.

Collections: DGLAKZ-13736, -13885, -13969 and -13972,

Fig. 5 : Tilia species from the Atagi bed.
A and B : *Tilia miqueliana*
C : *Tilia japonica*



Tilia miqueliana MAXIOMOWICZ

Plate VII, figures 1 and 2.

A deltoidal cordate leaf is the material concerned: it is very closely similar to the living *T. miqueliana* MAXIMOWICZ ("*Bodaiju*" in Japanese), which flourishes in China, and is planted in gardens in Japan.

The writer agrees with paleophytologists that the living species may have flourished in Japan in the Plio-Pleistocene age; the case is just the same as of *Ginkgo biloba* which is flourishing in China now.

In the following table and the text-figures, the writer tries to compare it with *T. japonica.*

Species	*Tilia miqueliana*	*Tilia japonica*
Shape	Ovate-deltoid or deltoidal cordate, Inequilateral form.	Cordate, Inequilateral form.
Serration	Serrate.	Serrulate.
Apex	Attenuate-acuminate.	Acuminate.
Base	Inequilateral cordate.	Cordate, Inequilateral cordate.

Locality: Hokuno.

Collections: DGLAKZ-13776 and -13747.

Hydrocaryaceae

Trapa natans LINNÉ

Plate VIII, figure 4.

A number of specimens are in the writer's collection. They show that the species is closely allied to the living *Trapa natans* LINNE var. *bispinosa* MAKINO ("*Hishi*" in Japanese), which lives in the pond and marsh in Japan. It has a two-armed spines and inflated base at calyx tube. The living species therefore, is very similar to the Pliocene species *T. dolichocarpa* MIKI, which was established as a new species by S.MIKI (1952: 23, II, fig. B and Text-figs. 11, H-I) from the Lignite bed in Aichi Prefecture.

When he described the new species, he gave the new Japanese name "*Inubishi*" and characterized it as follows "—The shape of the species seems as *Trapa colchica* ALBOFF but it differs by two-armed, smaller scar of peduncle and by narrow acute horn".

However, the Minoshirotori specimens more closely resemble the living species than the Pliocene fossil species *T. dolichocarpa.*

Locality: Chujo.

Collection : DGLAKZ-13931.

Trapa maximowiczii KORSH.

Plate VIII, figure 7.

This small Trapa very closely resemble the Plio-Pleistocene species *Trapa maximowiczii* KORSH., which was reported by S.MIKI from the Japanese Islands who gave the new Japanese name *"Tairiku-himebishi"*.

This species is similar to the living species *T. incisa* SIEB. et ZUCC. (*"Hime-bishi"* in Japanese), and compared it with the fossil species with *T. maximowiczii* (1952; 16, fig. 9): and MIKI remarks as follows " ..... This species (*T. maximowiczii*) at a glance seems as *Trapa incisa* S. et Z., but it is distinguished by the existence of extruded ring-like scar of peduncle and tube-like ovarial protuberance."

The writer considers this Minoshirotori species represents an ancestor form of the living species *T. incisa.*

Locality: Chujo.

Collection: DGLAKZ-13934.

Trapa mamillifera MIKI

Plate VIII, figures 1, 5 and 6.

The specimens at hand are very closely allied to the Pliocene species *Trapa mammillifera,* which was described by S.MIKI in 1938 (1952; 16, fig. 8, II, fig. C), who named the species *"Ibo-bishi"* in Japanese, which means tubercled water-caltrop.

Locality: Chujo.

Collections: DGLAKZ-13937, -13938 and -13939.

Haloragaceae

This family is composed of some such genera *Haloragis, Myriophyllum,* etc. that are cosmopolitan in distribution, occurring in ponds, slow streams, and shallow lakes.

Myriophyllum cfr. spicatum LINNÉ

Plate VII, figure 9.

1940 *Myriophyllum* cfr. *spicatum,* ENDÔ. 69, XI (VIII), fig. 23; XII (IX), fig. 2 (may be floating leaf).

An incomplete leaf impression at hand very closely resemble the Shiobara species, *Myriophyllum* cfr. *spicatum*, as was called by S.Endô in 1940 after the living species *M. spicatum* Linne (*"Kingyomo"* and *"Hozaki-no-fusamo"* in Japanese), which has a wide altitudinal range in the Northern Hemisphere, from near sea level up into the higher forest zones.

Description: Aquatic herb. Leaves in whorls from 3 to 16 mm. long and 0.5 mm. wide; thin filamentous texture.

Further, this Minoshirotori specimen has a very close resemblance to the living species *M. verticillatum* Linné (*"Fusamo"* in Japanese), the habitat of which as the *"Kingyomo"*.

Locality: Atagi.

Collection: DGLAKZ-13760.

Ericaceae

Tripetaleia bracteata MAXIMOWICZ

Plate VII, figure 7.

1940: *Tripetaleia bracteata* Maximowicz; Endô, 73; XI (VIII), fig. 25.

These small Ericaceous leaves are very much like the Shiobara species *Tripetaleia bracteata* Maximowicz, which was reported by S.Endô in 1940; he compared it with the Recent species *T. bracteata* (*"Miyamahotsutsuji"* in Japanese), which lives in association with species of the alpine plants in Central Honshu, Japan.

Locality: Hokuno.

Collections: DGLAKZ-13757, and -13776.

Ebenaceae

Cfr. Diospyros kaki THUNBERG

Plate V, figure 9.

A short petiole bearing incomplete leaf the material: it is similar to the living species *Diospyros kaki* Thunberg (*"Kaki"* in Japanese), which is found in the mountaineous territories of Southwestern Japan.

The Miocene species *Diospyros miokaki* Hu et Chaney is reported from the middle Miocene floras of Japan: especially, the Utto species (K.Huzioka; 1963, 213-214, XXXVIII, figs. 9 and 10) is very closely resembling the Minoshirotori material.

Locality: Hokuno.

Collection: DGLAKZ-13793.

Zosteraceae (Syn. Potamogetonaceae)

Potamogeton sp.

Plate I, figure 1.

The material consists of the impressions of the pond weed occurring in the muddy diatomaceous bed of the fine tuffaceous cross-bedding sandstone layer at Nishibora locality. These sediments appears to have accumulate in the delta of the Minoshirotori lake which might have played the part of the present day fresh-water pond and streams flowing in, where today *Potamogeton* species (Japanese name is "*Hirumushiro*") commonly grows.

Description: Folium natans; tip and base lacking, integer in margin; acrodromous in veining, midrib comparatively firm, 4-6 in numbers; texture thin.

The leaves of this pondweed are in two forms, namely, floating leaves and submersed leaves. The materials from Nishibora are the former, which very closely resemble the living species *P. distinctus* A. BENNET, *P. cristatus* REGEL et MAACK., and *P. octandrus* POIRET var. *miduhikimo* HARA found in Japan. As to the habitats of these three species, the former two thick in ponds, ditch-water and rice-fields, while the other is found in lake and marsh. The present material, in this connection, seems to show some relationship to the Nishibora species, although, the Nishibora materials are no less closely resemble the pond-living species in the size and shape.

The Pliocene species *P. verdiana* AXELROD (1958: 131, XVII, fig. 1) from the Verdi Flora of Western Nevada in N. America, has a very close resemblance to the Nishibora specimens: the latter, however, are larger than the other in general.

Locality: Nishibora.

Collection: DGLAKZ-13918.

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VIII: Glossary of Local, Stratigraphical Names, etc.

Atagi ……岐阜県郡上郡白鳥町阿多岐
Atagi bed ……阿多岐層（戸屋浩：1963年）
Chujô ……岐阜県郡上郡高鷲（タカス）村中将
Dainichidake……大日岳（1708.9m）
Etsubi-Nansen ……越美南線（美濃太田～北濃）
Gifu City ……岐阜県岐阜市
Gujôhachiman-machi ……岐阜県郡上郡郡上八幡町
Gujô hills ……郡上山地
Hakusan……白山（2,702m）
HAYASAKA Ichirô ……早坂一郎
Hida Plateau ……飛騨高原
Hirugano-kogen… ……蛭ケ野高原
Hokunô ……岐阜県郡上郡白鳥町北濃
Kaibutsu ……岐阜県郡上郡郡上八幡町字戒仏
Kanazawa City……石川県金沢市
Minoshirotori Flora……美濃白鳥植物群（戸屋浩：1963年(MS)）
Minoshirotori-ko ……美濃白鳥湖（戸屋浩：1963年(MS)）
Nagara-gawa……長良川
NAKAMURA Sadao……中村貞夫（1964年金沢大卒）
Naru flora……那留植物群（松尾秀邦：1962年）
Nishibora ……岐阜県郡上郡高鷲村西洞
Nôhi rhyolitic rocks……濃飛流紋岩類
Omodani rhyolitic rocks……面谷流紋岩類
Shirotori machi ……岐阜県郡上郡白鳥町
TOYA Hiroshi ……戸屋浩（1963年金沢大卒）
Washigatake ……鷲ケ岳（1671.6m）

Plate I.

Fig. 1 : *Potamogeton* sp.
Locality : Nishibora.
Reg. No. : DGLAKZ-13918.

Fig. 2 and 3 : *Taxas cuspidata* SIEBOLD et ZUCCARINI
Locality : Kaibutsu.
Holotype=DGLAKZ-13916b (fig. 3).
Hypotype=DGLAKZ-13903 (fig. 2).

Fig. 4 : *Picea polita* CARRIÈRE
Locality : Kaibutsu.
Holotype=DGLAKZ-13900.

Fig. 5 : *Pinus* sp.
Locality : Atagi.
Reg. No. : DGLAKZ-13947.

Fig. 6 : *Carpolithes* sp. (no description).
Locality : Hokuno.
Reg. No. : DGLAKZ-13792.

Figs. 7 and 10 : Cfr. *Thujopsis dolabrata* SIEBOLD et ZUCCARINI
Locality : Chujo.
Reg. Nos. : DGLAKZ-13950 (fig. 7). and-13964 (fig. 10).

Figs. 8, 9 and 11 : Cfr. *Cryptomeria japonica* D. DON
Localities : Atagi and Kaibutsu.
Reg. Nos. : DGLAKZ-13903 (fig. 8; Kaibutsu), -13909 (fig. 9 ; Kaibutsu) and -13927 (fig. 11. Atagi).

Figs. 12 and 14: *Carpinus tschonoskii* MAXIMOWICZ
Locality : Hokuno.
Reg. Nos. : DGLAKZ-13739 (leaf) and -13788 (involucre).

Fig. 13. *Carpinus laxiflora* BLUME
Locality : Hokuno.
Reg. No. : DGLAKZ-13737.

Fig. 15 : Cfr. *Corylus heterophylla* FISCH.
Locality : Hokuno.
Reg. No. : DGLAKZ-13943.

PL. I

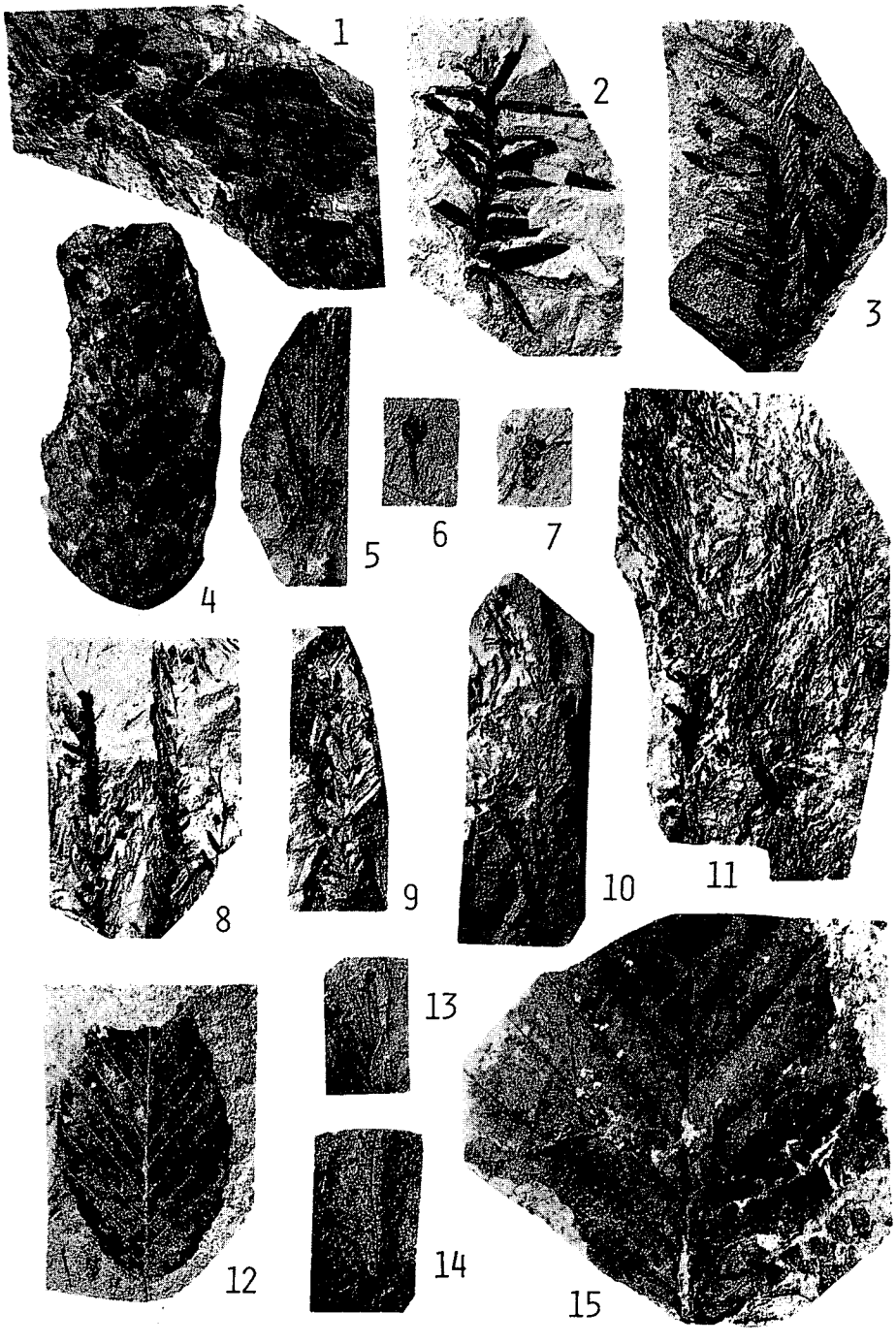

PHOTO. H. MATSUO

Plate II.

Fig. 1 : *Alnus hirsuta* TURCZANINOW
Locality : Hokuno.
Reg. No. : DGLAKZ-13786.

Figs. 2 and 3 : *Carpinus laxiflora* BLUME
Locality : Hokuno.
Reg. Nos. : DGLAKZ-13787 (fig. 2) and -13863 (fig.3).

Figs. 4 and 6 : *Viburnum* ? sp. (no description).
Localities : Hokuno and Chujo.
Reg. Nos. : DGLAKZ-13748 (fig. 4 ; Hokuno) and -13968 (fig. 6 ; Chujo)

Fig. 5 : *Corylus* ? sp. (no description).
Locality : Chujo.
Reg. No. : DGLAKZ-13953.

Fig. 7 : *Carpinus cordata* BLUME
Locality : Hokuno.
Reg. No. : DGLAKZ-13894.

Fig. 8 : *Betula maximowicziana* REGEL
Locality : Atagi.
Reg. No. : DGLAKZ-13803.

PL. II

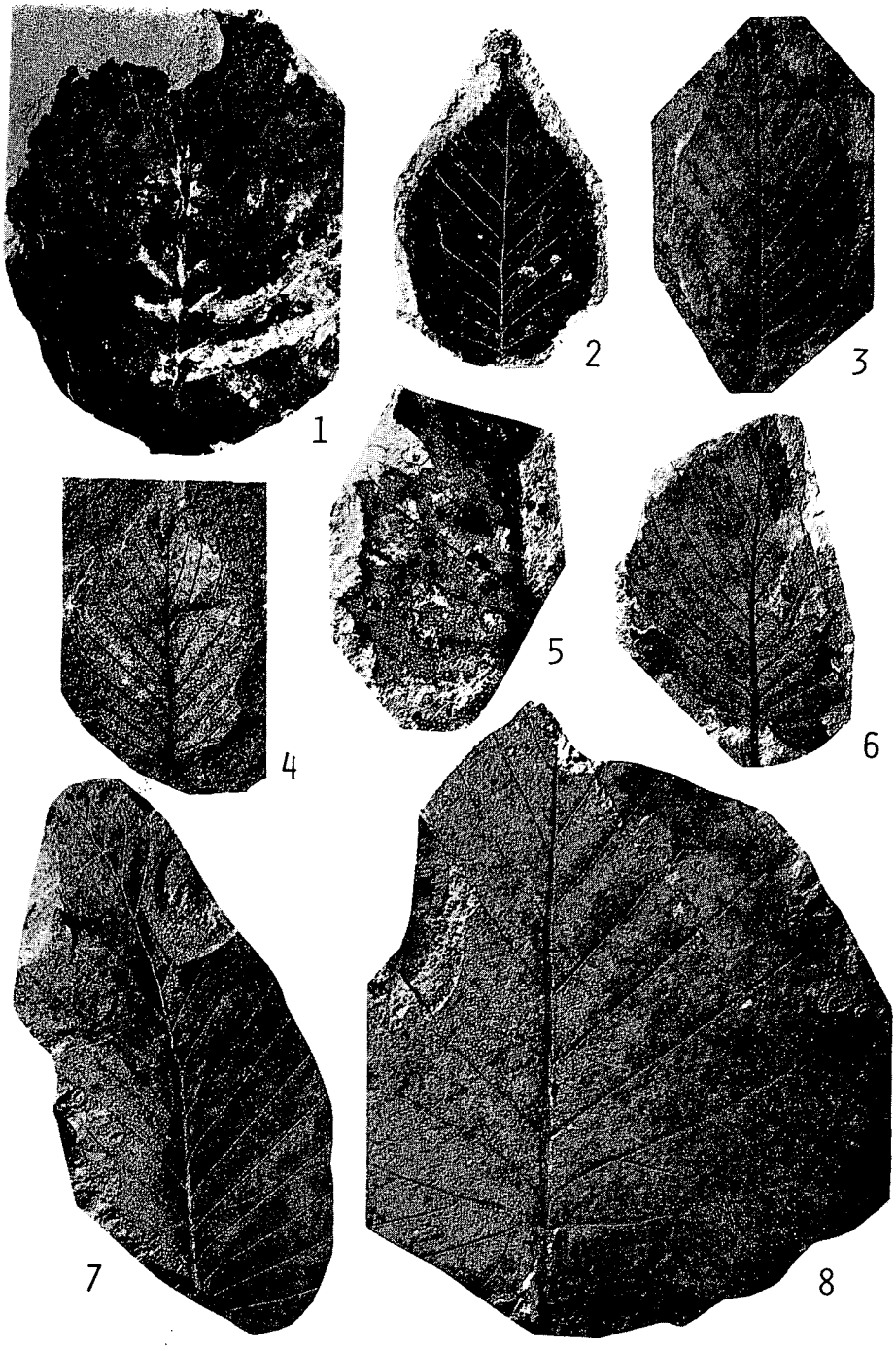

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Plate III.

Figs. 1-4, 8 and 9 : *Fagus crenata* BLUME
Locality : Hokuno.
Reg. Nos. : DGLAKZ-13786 (fig. 1), -13740 (fig. 2), -13752 (fig. 3), -13741 (fig. 4), -13789 (fig. 8) and -13791 (fig. 9).

Fig. 5 : Bud scale (no description).
Locality : Hokuno.
Reg. No. : DGLAKZ-13758.

Fig. 6a : *Quercus serrata* THUNBERG
Locality : Chujo.
Reg. No. : DGLAKZ-13956.

PL. III

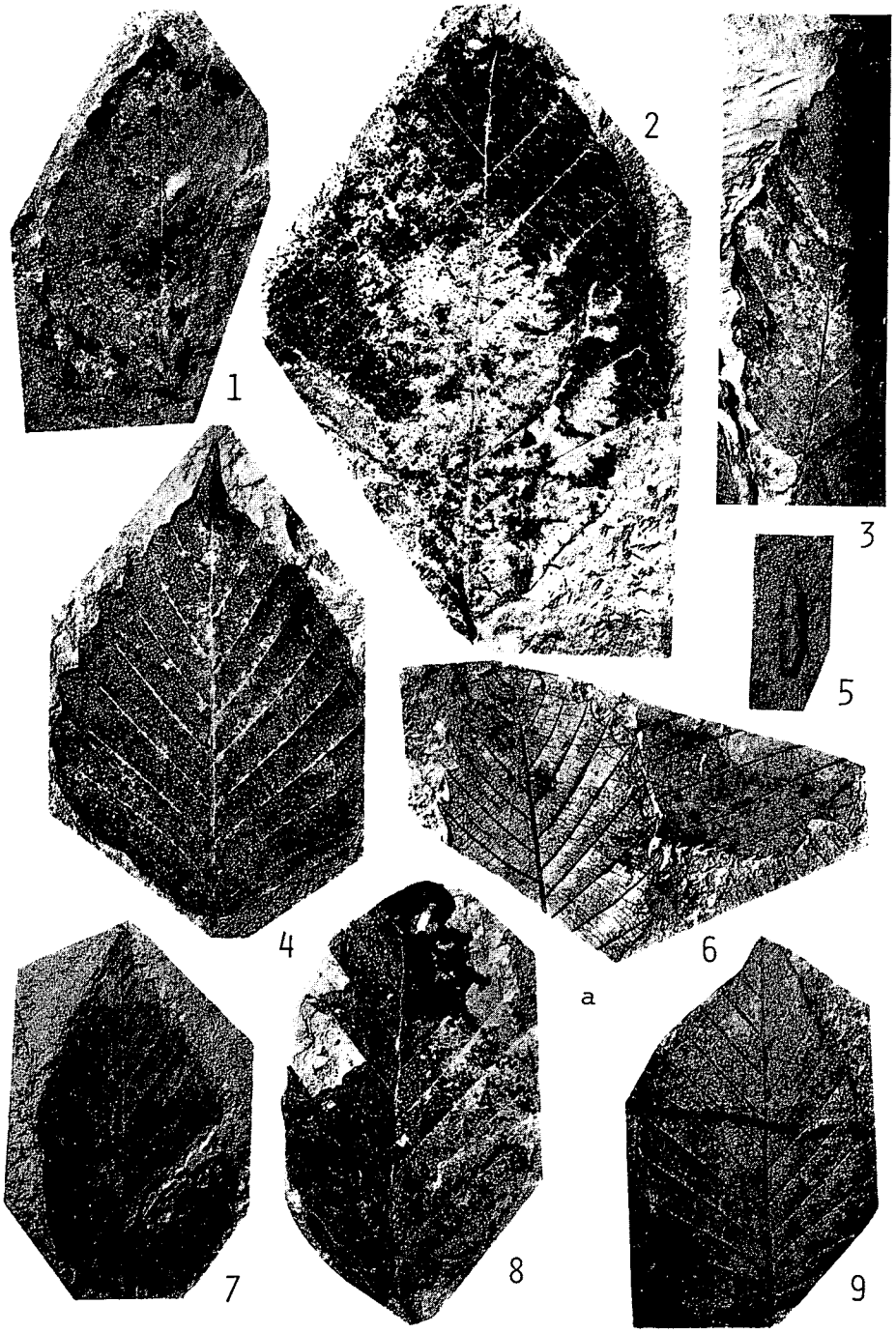

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Plate IV.

Figs. 1 and 8. *Fagus crenata* BLUME
Locality : Hokuno.
Reg. Nos. : DGLAKZ-13770 (fig.1) and -13734 (fig. 8).

Fig. 2 : *Quercus serrata* THUNBERG
Locality : Chujo.
Reg. No. : DGLAKZ-13952.

Figs. 3, 4 and 6 : *Quercus crispula* BLUME
Localities : Hokuno and Atagi.
Hypotypes =DGLAKZ-13790 (fig. 3 ; Hokuno), -13784 (Fig. 4 ; Hokuno) and -13858 (fig. 6 ; Atagi).

Fig. 5: *Euptelea* ? sp. (no description).
Locality : Atagi.
Reg. No. : DGLAKZ-13850.

Fig. 7 : *Ficus foveolata* WALL.
Locality : Hokuno.
Holotype=DGLAKZ-13736.

PL. IV

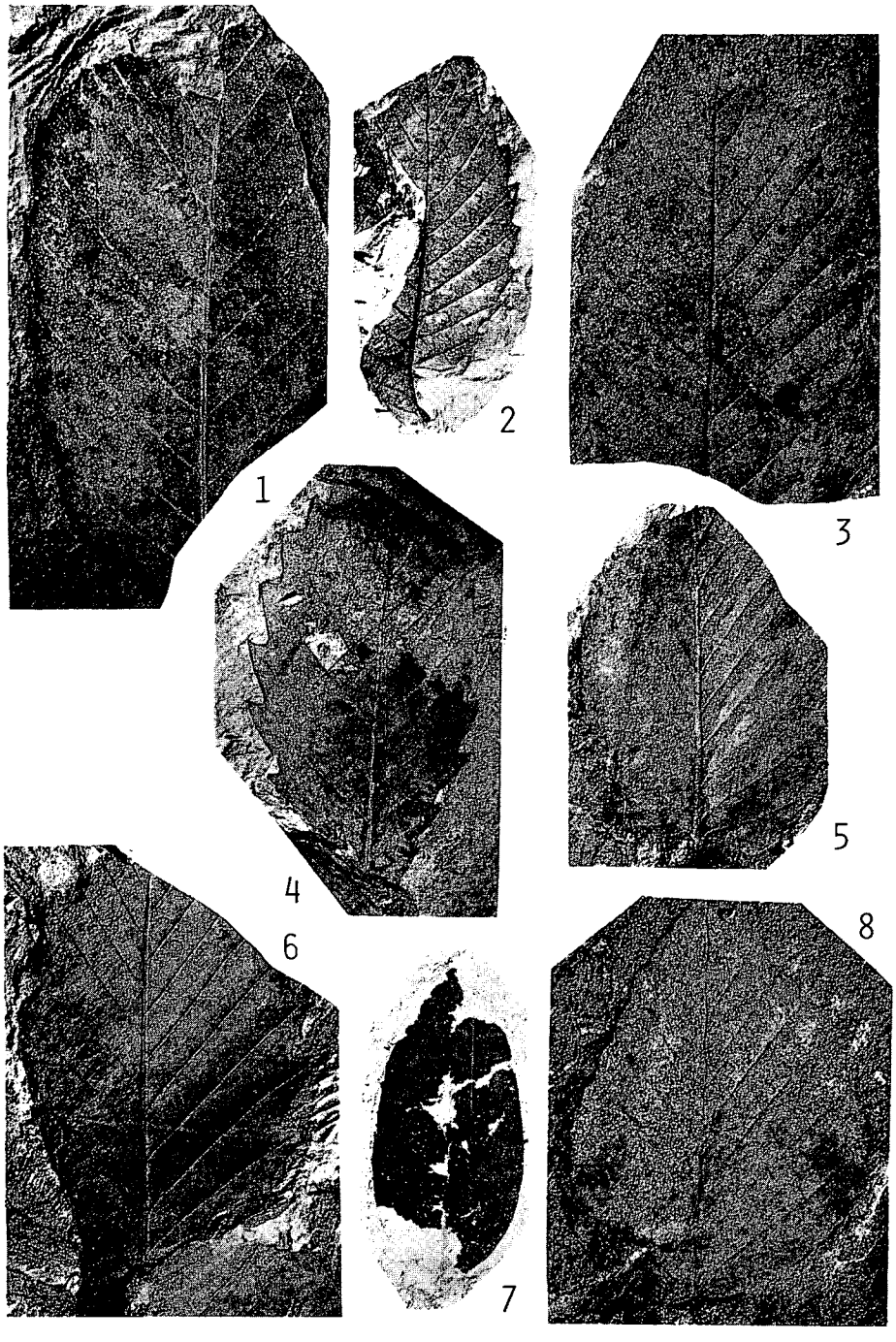

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Plate V.

Fig. 1 ; *Carpinus laxiflora* BLUME
Locality : Hokuno.
Reg. No. : DGLAKZ-13796.

Fig. 2 : *Carpinus japonica* BLUME (syn. *C. carpinoides* MAKINO) ? (no description).
Locality : Hokuno.
Reg. No. : DGLAKZ-13742.

Fig. 3 : *Quercus crispula* BLUME
Locality : Hokuno.
Hypotype = DGLAKZ-13753.

Figs. 4 and 5 : *Tilia japonica* SIMONKAI
Locality : Chujo.
Reg. Nos. : DGLAKZ-13969 (fig. 4) and -13972 (fig. 5).

Fig. 6 : *Parabenzoin* sp. ? (no description).
Locality : Hokuno.
Reg. No. : DGLAKZ-13776.

Figs. 7 and 8 : *Elaeocarpus japonicus* SIEBOLD et ZUCCARINI
Locality : Hokuno.
Hypotypes = DGLAKZ-13794 (fig. 7) and -13746 (fig. 8).

Fig. 9 : Cfr. *Diosyros kaki* THUNBERG
Locality : Hokuno.
Reg. No. : DGL AKZ-13793.

PL. V

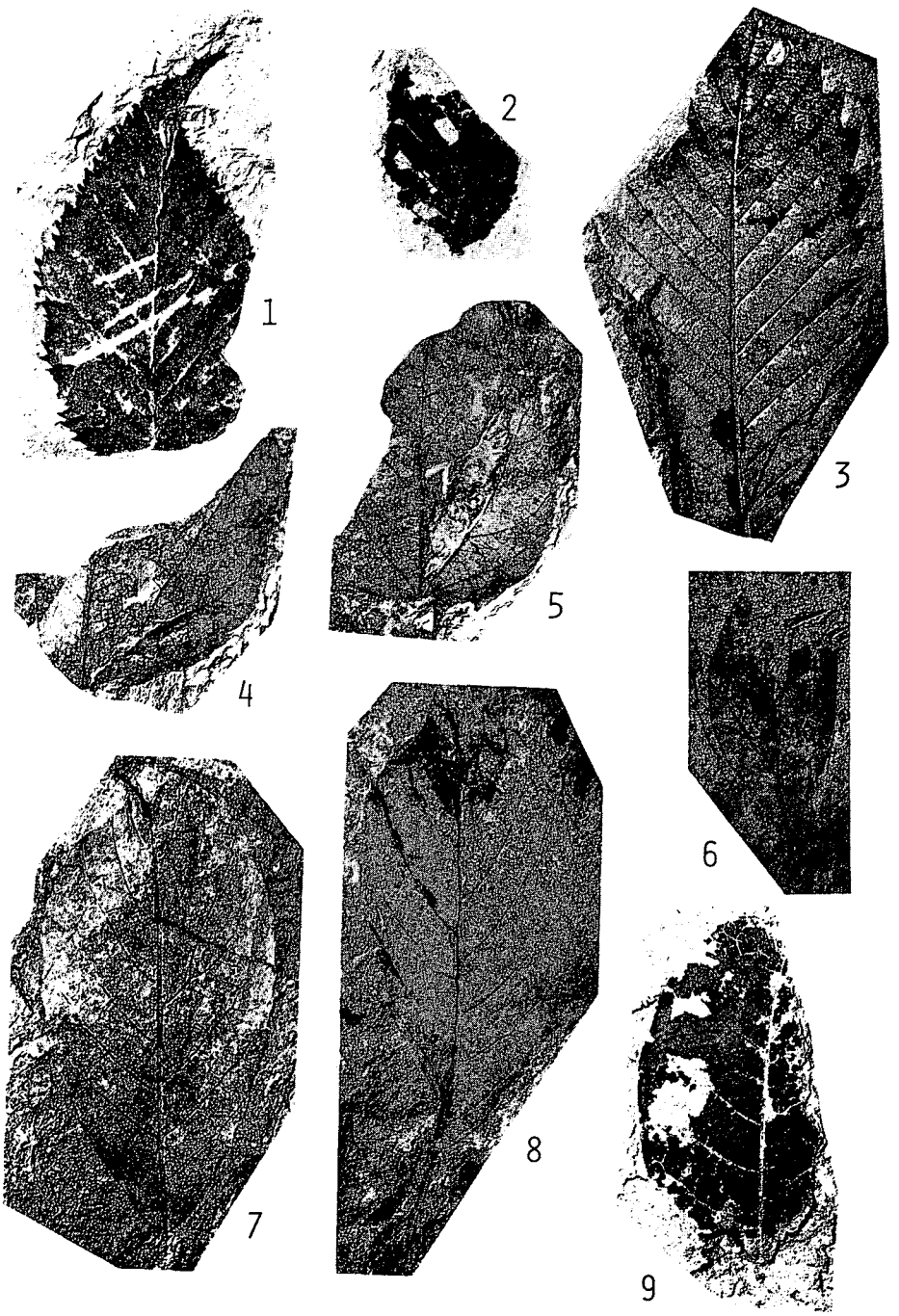

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Plate VI.

Figs. 1, 4 and 5 : *Acer mono* MAXIMOWICZ
Localities : Hokuno, Atagi and Chujo.
Reg. Nos. : DGLAKZ-13876 (fig. 1 ; Atagi), -13957 (fig. 4 ; Chujo) and -13769 (fig. 5 ; Hokuno).

Fig. 2 : *Acer* sp. ? (no description)
Locality : Hokuno.
Reg. No. : DGLAKZ-13772.

Fig. 3 : *Acer sieboldianum* MIQUEL
Locality : Hokuno.
Reg. No. : DGLAKZ-13789.

Fig. 6 : *Fagus crenata* BLUME
Locality : Atagi.
Reg. No. : DGLAKZ-13821.

Fig. 7 : *Trochodendron aralioides* SIEBOLD et ZUCCARINI
Locality : Hokuno.
Holotype=DGLAKZ-13797.

Figs. 8 and 9 : *Elaeocarpus japonicus* SIEBOLD et ZUCCARINI
Locality : Hokuno.
Holotype=DGLAKZ-13734 (fig. 9).
Hypotype=DGLAKZ-13780a (fig. 8).

PL. VI

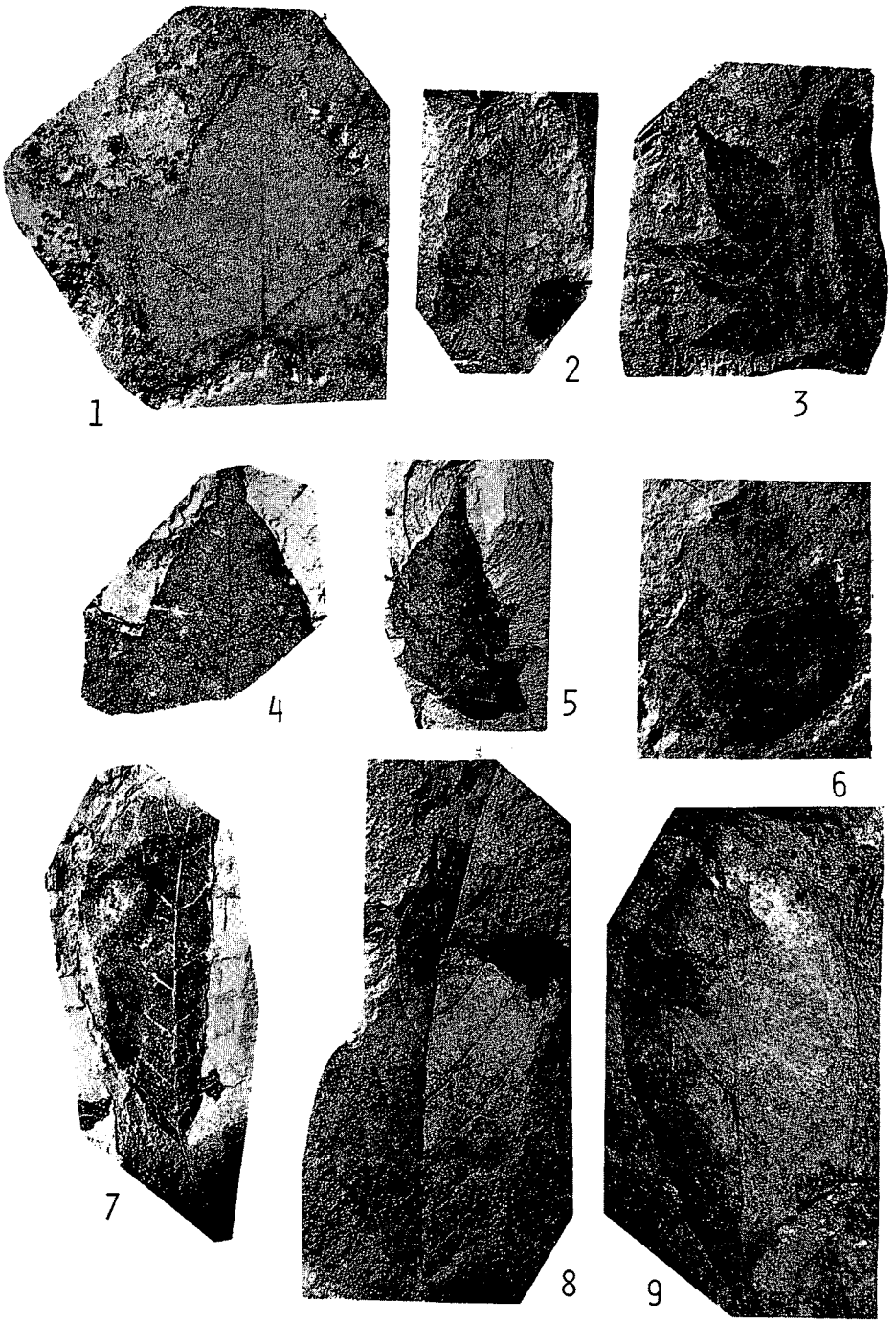

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Plate VII.

Figs. 1 and 2 : *Tilia miqueliana* MAXIMOWICZ
Locality : Hokuno.
Reg. Nos. : DGLAKZ-13747 (fig. 1) and -13776 (fig. 2).

Figs. 3 and 6 : *Tilla japonica* SIMONKAI
Locality : Hokuno.
Reg. Nos. : DGLAKZ-13736 (fig. 3) and -13885 (fig. 6).

Fig. 4 : *Euptelea* sp. ? (no description).
Locality : Kaibutsu.
Reg. No. : DGLAKZ-13908.

Fig. 5 : *Hydrangea* sp. ? (no description).
Locality : Hoknno.
Reg. No. : DGLAKZ-13735.

Fig. 7 : *Tripetaleia bracteata* MAXIMOWICZ
Locality : Hokuno.
Reg. No. : DGLAKZ-13757.

Fig. 8: *Rubus* sp. ? (no description).
Locality : Hokuno.
Reg. No. : DGLAKZ-13732.

Fig. 9 : *Myriophyllum* cfr. *spicatum* LINNÉ
Locality : Atagi.
Reg. No. : DGLAKZ-13760.

PL. VII

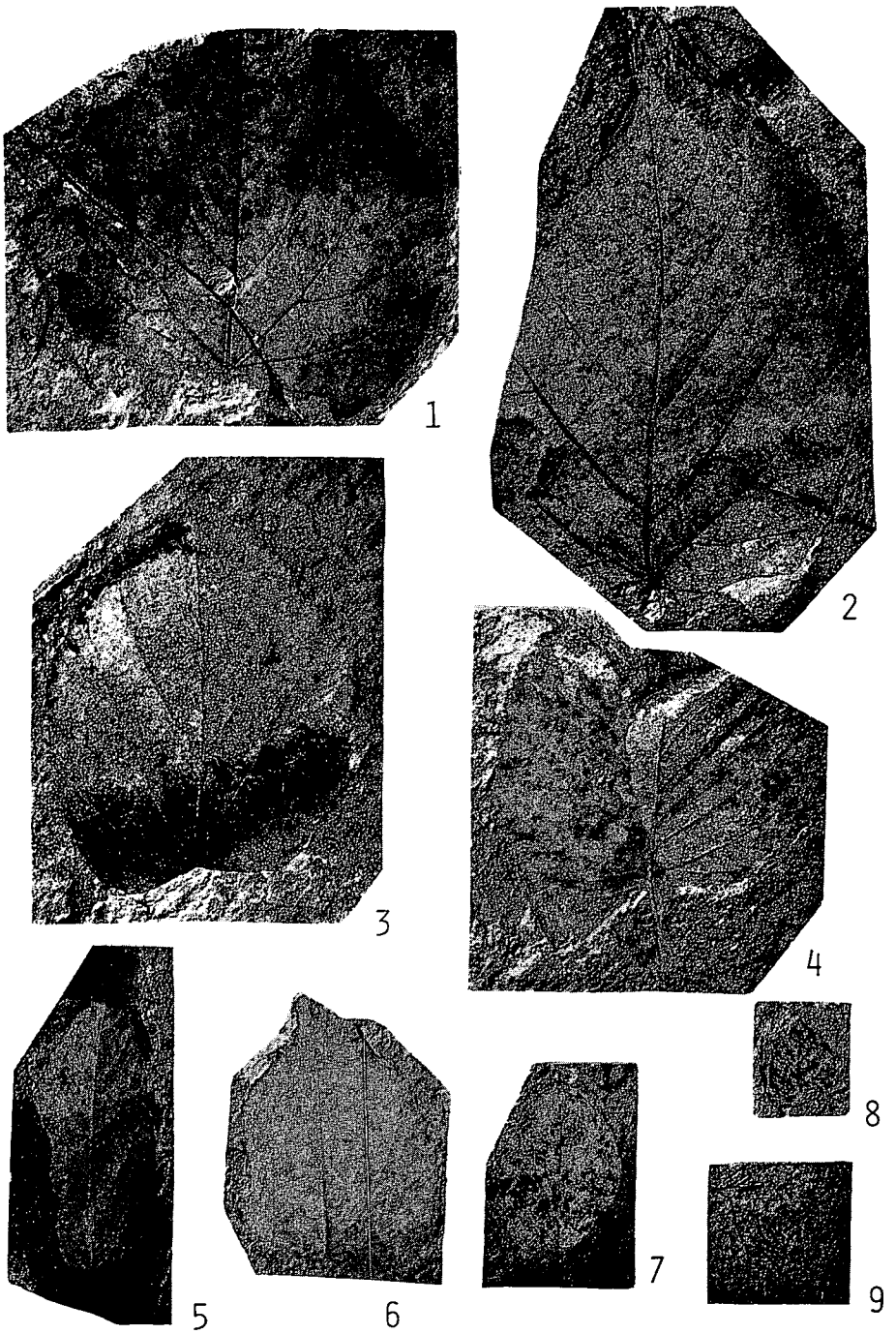

PHOTO. H. MATSUO

Plate VIII.

Figs. 1, 5 and 6 : *Trapa mammillifera* MIKI
Locality : Chujo.
Reg. Nos. : DGLAKZ-13937 (fig. 1), -13938 (fig. 6) and -13939 (fig. 5).

Fig. 2 : *Acer rufinerve* SIEBOLD et ZUCCARINI
Locality : Atagi.
Reg. No. : DGLAKZ-13802.

Fig. 3 : *Magnolia ovata* THUNBERG
Locality : Atagi.
Reg. No. : DGLAKZ-13867.

Fig. 4 : *Trapa natans* LINNE
Locality : Chujo.
Reg. No. : DGLAKZ-13931.

Fig. 7 : *Trapa maximowiczii* KORSH.
Locality : Chujo.
Reg. No. : DGLAKZ-13934.

PL. VIII

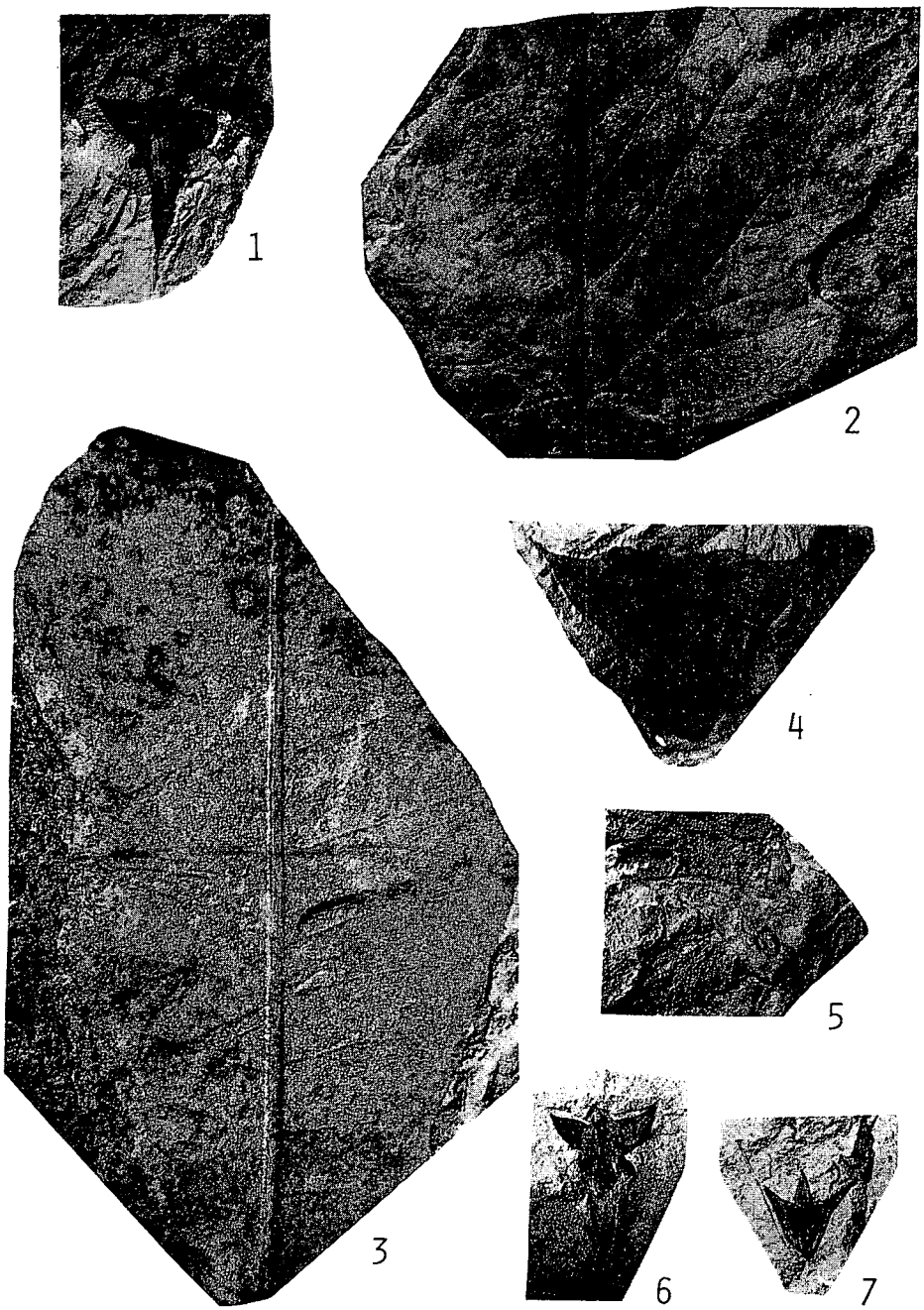

PHOTO. H. MATSUO